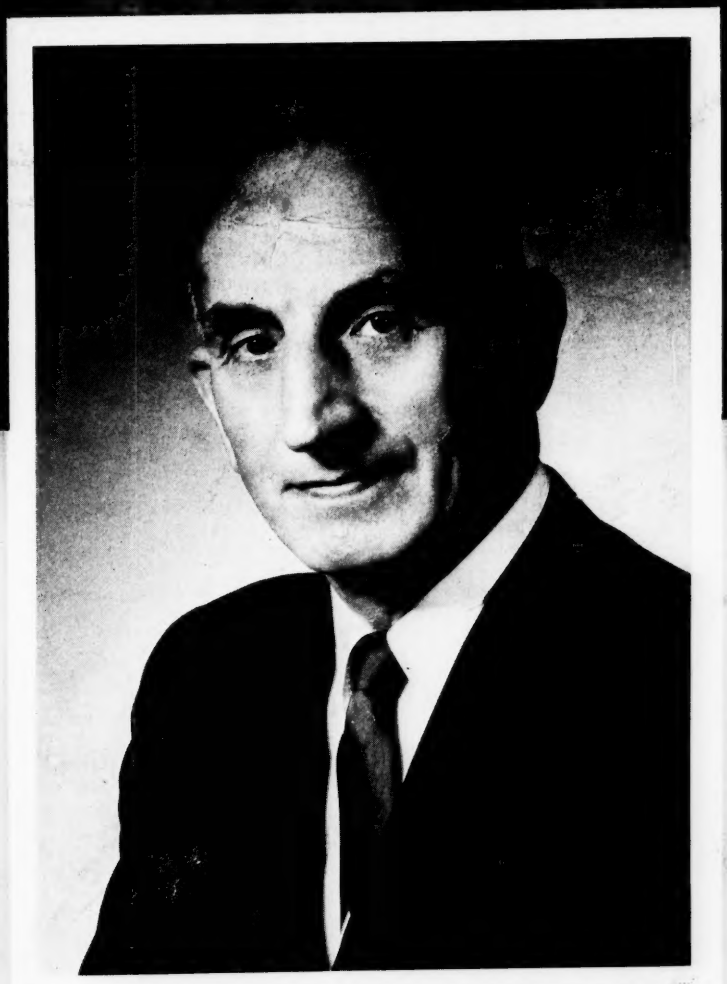
Metals Review

LOS ANGELES PUBLIC LIBRARY
SERIALS DIV.
630 WEST FIFTH ST.
LOS ANGELES 17, CALIF.



August 1959

C. H. Lorig
President A.S.M., 1958-59
(See Article, Page 4)

HOLDEN
METALLURGICAL PRODUCTS

TRADE MARK REGISTERED

HOLDEN SALT BATHS—*For Varied Applications.*	#200
HOLDEN SALT BATH FURNACES—*Gas, Oil & Electric—Designed for steel and ceramic pots for temperatures up to 2300° F. No size limitations with our electrodes for any heat application.*	#201
HOLDEN RECIRCULATING TYPE FURNACES—*Gas & Electric—To temperatures of 1750° F.*	#2
HOLDEN RADIVECTION FURNACES—*Gas & Electric.*	#207
HOLDEN DESCALING & DESANDING EQUIPMENT—*Also for rubber mold cleaning and paint removal.*	#203
HOLDEN INDUSTRIAL FURNACES—*For a wide variety of applications including conveyors, pushers, car furnaces.*	#205
HOLDEN INSTANTANEOUS HEAT—*Luminous Wall Combustion System 40% direct gas savings available for temperatures from 300-2300° F.*	#209
HOLDEN AUSTEMPERING-MARTEMPERING—*Isothermal Heat Treating; Variety of applications replacing oils.*	#206
HOLDEN PRESSURE NITRIDING—*For stainless steels, nitralloy steels, several classes of hot work die steels or hardenable steels.*	#204
HOLDEN CONVEYORS—*For Plating or Heat Treat Processing. 15-50% saving in floor space for almost any application.*	#210

Deliveries

Three F.O.B. points — Detroit — New Haven — Los Angeles

SALT BATHS: From stock: Shipment within 24-48 hrs. of receipt of order.

SALT BATH FURNACES: 4-8 weeks, depending on size, made possible by our manufacture of:

a. Our own transformers to our specifications.
b. Factory pre-wired electrical panels.
c. Our own electrodes and cables.
d. Furnaces at three f.o.b. points for early programming and lower freight costs.

INDUSTRIAL FURNACES: 6 - 14 weeks, depending on size and capacity. Our latest designs and prefabrication permit rapid installation where field erection is required.

See back cover for listing of free literature.

Realize 15% to 30% direct savings per year by use of Holden equipment.

THE A. F. HOLDEN COMPANY

Metals Review

The News Digest Magazine

August, 1959
Vol. XXXII, No. 8

Ray T. Bayless, Publishing Director

Betty A. Bryan, Editor

A. P. Ford, Sales Manager

G. H. Loughner, Production Manager

•

DISTRICT OFFICES

William J. Hilty
Rodney W. Cramer
Metals Park, Novelty, Ohio
JOrdan 4-2271

John B. Verrier, Jr.
Fred Stanley
342 Madison Ave., Room 1228
New York 17, N. Y.
OXford 7-2667

Victor D. Spatafora
53 West Jackson Blvd.
Chicago 4, Ill.
WAbash 2-7822

Donald J. Walter
20050 Livernois St.
Detroit 21, Mich.
UNiversity 4-3861

William F. Mills
(Whaley-Simpson Co.)
6608 Selma Ave.
Los Angeles 28, Calif.
HOllywood 3-7157

Gordon Simpson
(Whaley-Simpson Co.)
700 Montgomery St.
San Francisco 11, Calif.
SUtter 1-4583

•

Published monthly by the American Society for Metals, Metals Park, Novelty, Ohio: C. H. Lorig, President; Walter Crafts, Vice-President; R. H. Aborn, Treasurer; W. E. Jominy, Secretary; John H. Hollomon, E. E. Stansbury, Earl Parker and M. A. Scheil, Trustees; G. M. Young, Past President. Subscriptions $6.00 per year ($7.50 foreign). Single copies $1.50. Entered as Second Class Matter, July 26, 1930 at the Post Office at Cleveland, Ohio, under the Act of March 3, 1879.

Claims for missing numbers will not be allowed if received more than 60 days from date of issue. No claims allowed from subscribers from overseas, or because of failure to notify the circulation department of a change of address or because copy is "missing from files".

CONTENTS

Clarence H. Lorig, A.S.M. President, 1958-59 4

A.S.M. Chapter Officers, 1959-60 5

Seminar on High-Strength Metals (Minnesota Chapter) 14

Symposium on Metallurgy for the Space Age (Indiana Chapters) 15

Important Lectures

Plating and Finishing, by W. Glover 18

Radioisotopes for Metallurgical Research, by F. L. Green 19

Electric Arc Furnace Steelmaking, by D. J. Carney 20

Rockets, Mass Ratios and Space Flight, by H. Preston-Thomas . 21

Cold Forging, by J. F. Leland 21

Minimizing Heat Treating Distortion, by N. O. Kates 22

Vacuum Casting of Large Ingots, by N. V. Herasimchuk 23

Effect of Aging Treatment on Corrosion Resistance, by M. A. Scheil 25

Departments

Metals Engineering Institute .... 17 New Films 23

Compliments ..... 22 Obituaries 24

Employment Service Bureau 26

C. H. Lorig, Battelle Memorial Institute

A.S.M. President, 1958-59

An outstanding scientist who holds more than a dozen patents and has nearly 100 published papers, an efficient executive and highly respected leader, a willing worker in the many societies of which he is a member—this is Clarence H. Lorig, president of the American Society for Metals, and technical director, Battelle Memorial Institute.

When, in 1930, Clarence was hired by Horace Gillett, first director of the newly established Battelle Memorial Institute, he had just finished a year of engineering research at his alma mater, the University of Wisconsin, and a year of teaching as assistant professor at Drexel Institute. The association of Battelle and Clarence Lorig proved to be lasting and mutually beneficial. In adapting to and meeting the changing requirements of the metals field over the past three decades they have gained recognition and grown in stature together in metallurgical circles. Clarence has directed research in many areas at Battelle, including alloy development, heat treatment, metallugical practices, production methods and behavior of iron and steel. A great deal of our present knowledge of copper and phosphorus can be attributed to his studies. He holds patents on the making of steels, alloys and cast iron, surface cleaning of metals, improvement of valves and design of molds. In recognition of his distinction in metallurgical research he received the Joseph S. Seaman Gold Medal from the American Foundrymen's Society in 1950. But the object of his special interest over the years has been the refractory metals: tungsten, molybdenum, zirconium, titanium and chromium. The Pittsburgh Chapter A.S.M. presented the first William Hunt Eisenman Medal to him with a citation which read:

"In recognition of your outstanding dedication and service to the American Society for Metals, development of aims of the Society and in recognition of your leadership in guiding and stimulating research in the field of refractory metals and alloys for the advancement of the metals industry".

Mr. Lorig is an actively participating member of many technical societies as well as A.S.M., which he has served in the capacities of national treasurer and vice-president. A list of the societies to which he belongs shows his wide interest in all fields that have to do with metallurgy—they include the American Institute of Mining, Metallurgical and Petroleum Engineers, American Foundrymen's Society, American Society for Testing Materials, the Society of Automotive Engineers, Institute of British Foundrymen and the Alloys of Iron Research Committee of the Engineering Foundation.

In 1948, for work done during the Second World War on the War Metallurgy Committee, Dr. Lorig received the Armed Forces Certificate of Appreciation. Other distinctions which have been conferred on him were the invitation to give the A.S.M. Campbell Memorial Lecture at the 1951 World Metallurgical Congress and a citation from the University of Wisconsin's College of Engineering for his distinguished engineering services.

Even though all these activities take up much of his time, he still finds opportunities to enjoy a gracious home life with his charming wife, Esther, and his two children, Bruce and Marjorie. Clarence and his son, who is now attending Cornell on a Naval R.O.T.C. scholarship, share an interest in sailing and are avid members of the Leatherlips Yacht Club. Another of Clarence's attributes is a verdigris thumb which has a talent for growing out-of-season flowers and plants from foreign lands. Even this hobby has brought him more of the work and responsibility on which he thrives, for his neighbors have elected him president of the Kingswood Garden Club.

A.S.M. Given Air Force Work

Receipt of another Air Force contract by the A.S.M.'s Publication Development Division has been reported by Taylor Lyman, director of the Division.

The contract, from the Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, is for the preparation of a book on machinability of high-strength steel and certain high-temperature alloys.

A.S.M. Headquarters Go Photogenic

North American Aviation, Inc., Camera Men Film the A.S.M. Geodesic Dome at the New Headquarters Building for Special North American Films Showing Metals in Architecture. From left are: Jack Seely, cinematographer; William Cheatham, NAA cinematographer; Ralph Rose, NAA writer-director; and Ford Beebe, producer-director, Arco Enterprises, Hollywood, Calif. North American fabricated the 65,000 parts comprising the aluminum dome

Growing interest in the new headquarters office building of the American Society for Metals was emphasized again last month as a battery of movie and still cameras provided a Hollywood atmosphere in recording the dramatic structure for use by North American Aviation, Inc.

Fabricators of the geodesic dome, North American will feature the building in special films to demonstrate its activity with architectural metals. In charge of the crew that did the filming was Ralph Rose, Jr., writer-director for North American's documentary motion pictures.

CHAPTER OFFICERS, 1959-60

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
AKRON	Robert M. Moore H & M Metal Processing Co. 1950 Tudor St. Cuyahoga Falls, Ohio	Robert L. Rowe Peninsular Steel Co. 1461 Industrial Pkwy. Akron, Ohio	Charles L. Durell Babcock & Wilcox 195 25th, N.W. Barberton, Ohio	Roger E. Crassweller Goodyear Aircraft Corp. 1484 Ridpath Akron 13, Ohio
ALBERTA	F. W. Thompson 3224 28th Ave., S.W. Calgary, Alb., Canada	A. O. Pape 3035 Morley Trail Calgary, Alb., Canada	Gerard Cuerrier 5015 Stanley Rd. Calgary, Alb., Canada	
ALBUQUERQUE	Donald R. Johnson 516 Maple, S.E. Albuquerque, N. Mex.	Fred R. Sweet 3911 Hannett, N.E. Albuquerque, N. Mex.	Lewis P. Wilson 424 Wellesley, S.E. Albuquerque, N. Mex.	A. W. Porter 1618 Cornell Dr., N.E. Albuquerque, N. Mex.
ATLANTA	Elwin L. Smith 1590 Hubel St., N.W. Atlanta, Ga.	H. Scott Bandy 72-43 Eng. Res. Lab. Lockheed Aircraft Corp. Marietta, Ga.	Michael Wiedl, Jr. 2217 Virginia Pl., N.E. Atlanta 5, Ga.	Robert E. Davis Atlanta Steel Co. P. O. Box 1714 Atlanta, Ga.
BALTIMORE	Richard K. Wuerfel 103 S. Rolling Rd. Catonsville 28, Md.	Robert J. Harkel Metallurgical Dept. Bethlehem Steel Co. Sparrows Point 19, Md.	John S. White 901 Fairway Dr. Towson 4, Md.	
BIRMINGHAM	E. A. Brandler 2900 Cahaba Rd. P.O. Box 196 Birmingham 1, Ala.	J. F. Ellis American Cast Iron Pipe Co. Box 2603 Birmingham, Ala.	E. G. Balog T. C. I. Div., U. S. Steel Corp. P. O. Box 599 Fairfield, Ala.	
BOSTON	James L. Martin Watertown Arsenal Watertown, Mass.	W. H. McCarty, Jr. Latrobe Steel Co. Rice Bldg. Boston 10, Mass.	John D. Paine, Jr. United Shoe Machinery Corp. Beverly, Mass.	
BRITISH COLUMBIA	L. A. Mitten 5850 Athlone St. Vancouver 13, B. C., Canada	C. H. McNulty 215 W. 2nd Ave. Vancouver 10, B. C., Canada	John Billings 1220 Imperial St. S. Burnaby 1, B. C., Canada	J. A. Millcarch 757 W. 64th Ave. Vancouver 14, B.C. Canada
BUFFALO	Fred A. Webber 75 Clark St. Kenmore 17, N. Y.	Harry K. Jamesson 27 Deumant Terr. Kenmore 23, N. Y.	Emil M. Galbreath 198 Parkwood Ave. Buffalo 17, N. Y.	Maurice A. Grobe Chevrolet-Tonawanda P.O. Station "B" Buffalo, N. Y.
BUFFALO-ERIE COUNTY TECHNICAL INSTITUTE	Robert Wengewicz 66 Nandale St. Buffalo 25, N. Y.	Fred Kobot 40 First St. Buffalo 19, N. Y.	Anthony Piazza 58 Alys Dr., E. Depew, N. Y.	Lawrence Panek 300 Michael St. Buffalo 12, N. Y.
CALUMET	L. J. Zadra General American Transportation Corp. 143rd & Railroad Aves. E. Chicago, Ind.	W. R. Barnett U. S. Steel Corp., Gary Works 1 Broadway Gary, Ind.	J. B. Moore Northern Indiana Public Service Co. 5265 Hohman Ave. Hammond, Ind.	G. L. Armstrong U. S. Reduction Co. 4610 Melville Ave. E. Chicago, Ind.

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
CANTON-MASSILLON	G. P. Michalos Timken Roller Bearing Co. Canton, Ohio	C. D. Huff Griscom Russell Co. Massillon, Ohio	A. J. Gusky Republic Steel Corp. Canton, Ohio	J. A. Rinebolt Republic Steel Corp. Canton, Ohio
CAROLINAS	W. W. Austin, Jr. Dept. of Mineral Industries North Carolina State College Raleigh, N. C.	V. J. Vierling 784 Austin Lane Winston-Salem, N. C.	J. W. Schout 1000 Sedgefield Rd. Charlotte 9, N. C.	T. E. Gregory 1045 Huntington Rd. Winston-Salem, N. C.
CEDAR RAPIDS	Jennings C. Falcon 1429 Wildwood Dr., N.E. Cedar Rapids, Iowa	Morton A. Blum 1941 C Ave., N.E. Cedar Rapids, Iowa	Carol F. Shadle 800 35th St., N.E. Cedar Rapids, Iowa	
CHATTANOOGA	Donald J. Genung 1703 N. Hickory Valley Rd., N. E. Chattanooga 11, Tenn.	F. W. Drosten Heavy Minerals Co. Chattanooga, Tenn.	J. H. McMinn, Jr. 360 N. St. Marks Ave. Chattanooga 11, Tenn.	M. C. Stephens, Jr. 4612 Lake Hill Cir. Chattanooga, Tenn.
CHICAGO	R. J. Hibbeln 4805 Prospect St. Downers Grove, Ill.	J. H. Greenberg A. J. Boynton & Co. 109 N. Wabash Ave. Chicago 2, Ill.	Raymond R. Fritz Lindberg Engineering Co. 2450 W. Hubbard St. Chicago 12, Ill.	Robert Dallman Robert W. Hunt Co. 810 S. Clinton St. Chicago 7, Ill.
CHICAGO—JUNIOR SECTION	Donald C. Brillhart 1530 N. Austin Blvd. Oak Park, Ill.	John E. Henry 16022 Loomis Ave. Harvey, Ill.	Roy W. Lobenhofer 516 S. Greedwood Ave. Park Ridge, Ill.	Fred Gezella
CHICAGO—WESTERN	Paul K. Zimmerman Joseph T. Ryerson & Son, Inc. Box 8000-A Chicago 80, Ill.	N. K. Koebel Lindberg Engineering Co. 2450 W. Hubbard St. Chicago 12, Ill.	O. S. Spark Ohio Crankshaft Co. 6600 S. Nashville Ave. Chicago 38, Ill.	
CINCINNATI	A. J. Pfetzing 140 Kinsey Ave. Cincinnati 19, Ohio	Walter Koshuba G. E. ANP Box 132 Cincinnati 15, Ohio	David Foster, Jr. 31 E. Charlotte Ave. Wyoming 15, Ohio	Robert E. Bader 7148 Garden Rd. Cincinnati 36, Ohio
CLEVELAND				
COLUMBIA (S. C.)	Frank Cox 822 S. Bonham Rd. Columbia, S. C.	George H. Reed Hopkins, S. C.	David M. Crockett, Jr. 3822 Beverly Dr. Columbia, S. C.	M. K. Whetstone 1015 Whaley St. Columbia, S. C.
COLUMBIA BASIN	Robert S. Kemper, Jr. 1528 Sanford Richland, Wash.	Robert C. Wheeler 947 Long St. Richland, Wash.	W. V. Cummings, Jr. 2301 Olympic Richland, Wash.	Ivor D. Thomas 1106 Elm Richland, Wash.
COLUMBUS	John G. Kura Battelle Memorial Institute 505 King Ave. Columbus 1, Ohio	Anthony M. Federico North American Aviation Inc. 3291 Livmoor Dr. Columbus 13, Ohio	R. Ernest Christin Electric Heat Treating Co. P. O. Box 1115 Columbus 16, Ohio	E. M. Sherwood Battelle Memorial Institute 505 King Ave. Columbus 1, Ohio
DAYTON	David C. Heckard 3100 Shadow Hill Rd. Middletown, Ohio	Richard Grayson 4965 Silvercrest Terr. Dayton 10, Ohio	Charles F. Heckel 45 Thorpe Dr. Dayton 10, Ohio	William D. Walther 432 Canterbury Dr. Kettering 29, Ohio

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
DELAWARE VALLEY	R. H. Saviers Black Rock Rd. & Stackhouse Dr. Yardley, Pa.	H. J. Godfrey John A. Roebling's Sons Co. 640 S. Broad St. Trenton, N. J.	J. F. Georgiadis Glenn Valley, R. D. Morrisville, Pa.	W. E. Johannsen 146 King George Rd. Pennington, N. J.
DES MOINES	John F. Smith 1218 S. 3rd St. Ames, Iowa	Adrian Daane 2817 Oakland St. Ames, Iowa	M. L Patzig, Jr. 2215 Ingersoll Des Moines, Iowa	
DETROIT	Donald J. Henry 139 Northwood Rochester, Mich.	Robert B. Boswell 5674 Westwood Ct. Birmingham, Mich.	Robert Sergeson 360 Tilbury Rd. Birmingham, Mich.	
EASTERN NEW YORK	Garland W. Reese, Jr. Allegheny Ludlum Steel Corp. Watervliet, New York	Ray W. Guard G. E. Research Laboratory (Knolls) Schenectady, N. Y.	W. G. Fabofsky General Electric Co. 273 North Ave. Schenectady, N. Y.	John J. McCarthy Dept. of Metallurgical Eng. Rensselaer Polytechnic Institute Troy N. Y.
EDMONTON	Richard E. Hardie 11622 128th St. Edmonton, Alb., Canada	John Tuskey Premier Steel Mills Box 348 Edmonton, Alb., Canada	F. Richard Clift 10728 165th St. Edmonton, Alb., Canada	George Harcus 9747 86th Ave. Edmonton, Alb., Canada
FORT WAYNE	Dick W. Hemphill Dana Corp. 2100 W. State Fort Wayne, Ind.	James P. Crosbie International Harvester Co. 2701 Bueter Rd. Fort Wayne, Ind.	N. W. McClymonds, Sr. Joslyn Stainless Steel 1701 McKinley Ave. Fort Wayne, Ind.	Floyd T. Steffens Dana Corp. 2100 W. State Fort Wayne, Ind.
GOLDEN GATE	Robert L. Nichols 18 Don Gabriel Way Orinda, Calif.	Robert C. Bertossa 361 Tioga Ct. Palo Alto, Calif.	Norman W. McLeod 2937 Mullens Dr. Richmond, Calif.	Thomas E. DeHart 214 Kensington Dr. Irvington, Calif.
HARTFORD	W. R. Yerger Associated Spring Corp. Bristol, Conn.	E. F. Bradley Pratt & Whitney Div., United Aircraft Corp. E. Hartford, Conn.	T. P. Hanford The Stanley Works New Britain, Conn.	Henry Hubbell Fafnir Bearing Co. 37 Booth St. New Britain, Conn.
INDIANAPOLIS	Charles C. Patton 6502 E. 56th St. Indianapolis 26, Ind.	George F. Sommer Linkbelt Co. P.O. Box 346 Indianapolis, Ind.	D. K. Hanink Allison Div., GMC. Met. Lab. Plant 5 Indianapolis 6, Ind.	John E. Mitchell 902 N. Belmar Indianapolis 19, Ind.
INLAND EMPIRE	F. W. DeMoney S. 1405 McDonald Rd. Spokane 65, Wash.	John E. Fowler Eagle Metals Co. Helena at Broadway Spokane 24, Wash.	S. G. Roberts S. 1707 Bowdish Rd. Spokane 64, Wash.	
JACKSON, (MICH.)	William J. Levy 740 Woodfield Dr. Jackson, Mich.	W. C. Truckenmiller 29260 Concord Rd. Rt. 1, Albion, Mich.	Charles E. Gumbert 4022 Horton Rd. Jackson, Mich.	Thomas I. Clark Fab-Alloy Co. 703 Adrian Ave. Jackson, Mich.
JACKSONVILLE	Anthony Breda 2302 Tegner Dr. Jacksonville 10, Fla.	H. M. Courtenay, Jr. 5066 French St. Jacksonville 5, Fla.	John H. Repp 6436 Solandra Dr. Jacksonville 5, Fla.	Frank Worley 4629 Royal Ave. Jacksonville 5, Fla.
KANSAS CITY	W. H. Deterding 9005 Belleview Kansas City 10, Mo.	Edwin Cornelius 8401 Walmer Overland Park, Kan.	Gerald Hummon Sheffield Steel Corp. Kansas City 3, Mo.	Joseph Hershe 2115 Clay St. N. Kansas City 16, Mo.

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
LEHIGH VALLEY	H. O. Beaver, Jr. Carpenter Steel Co. Reading, Pa.	J. Byron Godshall Ingersoll Rand Co. Phillipsburg, N. J.	Otto Ehrsam, Jr. 1614 Fairmount St. Bethlehem, Pa.	Robert H. Holloway Bethlehem Steel Co. Bethlehem, Pa.
LONG ISLAND	George F. Stradar Fairchild Camera & Instrument Corp. Robbins Lane Syosset, L. I., N. Y.	John J. Carroll Grumman Aircraft Engineering Corp. Bethpage, L. I., N. Y.	Richard A. Richards Republic Aviation Corp. Farmingdale, L. I., N. Y.	Harold Forgosh Bausch & Lomb Optical Co. 730 5th Ave. New York, N. Y.
LOS ALAMOS	Thomas I. Jones, Jr. 531 Rim Rd. Los Alamos, N. M.	Robert D. Reiswig 973 Nambe Loop Los Alamos, N. M.	John E. Hockett 2582-A 36th St. Los Alamos, N. M.	
LOS ANGELES	H. A. Curwen 1007 Brockman Bldg., 520 W. 7th St. Los Angeles 14, Calif.	W. V. Ward 1007 Brockman Bldg. 520 W. 7th St. Los Angeles 14, Calif.	K. L. Clark 1007 Brockman Bldg. 520 W. 7th St. Los Angeles 14, Calif.	Edward W. Golda 1007 Brockman Bldg. 520 W. 7th St. Los Angeles 14, Calif.
LOUISVILLE	W. F. Melhorn Tube Turns, Inc. 28th & Broadway Louisville, Ky.	R. L. Hadley General Electric Co. Appliance Park, Ky.	C. L. Owen, Jr. International Harvester Crittenden Dr. Louisville, Ky.	
MAHONING VALLEY	J. Gilbert Cutton 247 Maywood Dr. Youngstown 12, Ohio	John F. Beale 283 Oakley Ave. Youngstown, Ohio	Edward J. Miller 456 Catalina Ave. Youngstown 4, Ohio	
MANITOBA				
MEDICINE HAT	D. R. Walker 81 Huckvale Cresc. Medicine Hat, Alb. Canada	Poen Hartog 162 1st St., S. W. Medicine Hat, Alb. Canada	K. D. Awrey 164 1st St., N. W. Medicine Hat, Alb. Canada	F. N. Butterfield 478 Connaught Dr. Medicine Hat, Alb. Canada
MIAMI	Warren W. Smith 170 N.W. 144th St. Miami 50, Fla.	Frank J. Callahan 6040 S.W. 104th St. Miami 43, Fla.	Jack H. Palmer 1401 N.W. 69th Way West Hollywood, Fla.	
MICHIGAN COLLEGE OF MINING AND TECHNOLOGY	E. William Olson 418 Lovell Rd. Houghton, Mich.	William Duca Douglas Houghton Hall Room 240 Houghton, Mich.	Miss Marie Kohl Smith House 1611 E. Houghton Ave. Houghton, Mich	
MILWAUKEE	P. C. Rosenthal University of Wisconsin 3668 Lake Mendota Dr. Madison 5, Wis.	E. M. Taussig, Jr. U. S. Steel Corp. 208 E. Wisconsin Ave. Milwaukee, Wis.	E. G. Guenther Wisconsin Motor Corp. 3336 N. Downer Ave. Milwaukee 11, Wis.	
MINNESOTA	Russell H. Lauderdale 4321 43rd Ave., N. Robbinsdale 22, Minn.	James A. McLaughlin E. F. Houghton & Co. 130 Washington Ave. Hopkins, Minn.	Lillian K. Polzin 302 Wesley Temple Bldg. Minneapolis 3, Minn.	
MISSOURI SCHOOL OF MINES	Kenneth I. Pendleton 206 E. 12th St. Rolla, Mo.	William F. Priesmeyer 3457 St. Mark Lane St. Ann, Mo.	Donald G. Cooper Rt. 2 Rolla, Mo.	Donald C. Stih 1804 N. Olive St. Rolla, Mo.

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
MOHAWK VALLEY	John S. Huntington 16 Forest Rd. Utica, N. Y.	Stephen H. Thurber 354 Sherrill Rd. Sherrill, N. Y.	John George Zieman 1462 Herkimer Rd. Utica, N. Y.	Arthur P. Lane 1644 Elm St. Utica, N. Y.
MONTREAL	H. H. Yates Dept. of Met.Eng. McGill University Montreal 2, Que., Canada	P. M. Howard Rolls-Royce of Canada Ltd. P. O. Box 1400, Station "O" Montreal 9, Que.	S. D. Entwistle Northern Electric Co. Ltd. 1261 Shearer St. Montreal 22, Que., Canada	
MUNCIE	Harold L. Reeves 216 S. Nichols Ave. Muncie, Ind.	John A. Buxton Glascock Bros. Mfg. Co. Muncie, Ind.	Charles R. Jones 604 High School Rd. Rushville, Ind.	
NEW HAVEN	Frederick E. J. Storm Chase Brass & Copper Co. 236 Grand St. Waterbury 20, Conn.	Joseph M. Halloran 63 Mowry St. Hamden 18, Conn.	John M. Quinn 24 Gen. Patton Dr. Naugatuck, Conn.	Roy C. Raymond 355 Wilbar Dr. Stratford, Conn.
NEW JERSEY	Anthony A. Scafati W. Glen Rd. Rock Ridge Lake Denville, N. J.	Henry F. J. Skarbeck 1075 Woolley Ave. Union, N. J.	R. B. Christofferson 46 Marion Rd. Verona, N. J.	Richard W. Thorne 43 Hillside Ave. Caldwell, N. J.
NEW ORLEANS	Jack L. Shutek 4621 Lynhuber Dr. New Orleans 22, La.	Emmerson Kemp 4623 Lynhuber Dr. New Orleans, La.	Leroy L. Newman, Jr. Newman Engineering Box 4156 New Orleans 18, La.	
NEW YORK	L. L. Seigle Sylvania Research Laboratories Bayside, New York	Ludwig Anselmini International Nickel Co. 67 Wall St. New York 5, N. Y.	Angelo V. Alessandria Arabian American Oil Co., Rm. 1412 505 Park Ave. New York, N. Y.	J. Edward Krauss New York City Community College 300 Pearl St. Brooklyn 1, N. Y.
NORTH CAROLINA STATE COLLEGE	Rayvine Hanford 501 N. Boundary St. Raleigh, N. C.	Ronald K. Bridgers Box 15042 State College Station Raleigh, N. C.	Robert A. Draughn Box 5667 State College Station Raleigh, N. C.	Gary S. Sheffield 1805 Madison Ave. Greensboro, N. C.
NORTHEAST PENNSYLVANIA	R. L. Ward R.D. 5 Towanda, Pa.	J. C. Frank 154 Willow St. Wilkes-Barre, Pa.	F. R. Yurkoski, Jr. Main St. Mocanaqua, Pa.	
NORTHERN ONTARIO	W. P. Dowhaniuk 98 Mark St. Sault Ste. Marie, Ont	J. B. McNichol Bar & Strip Mill Lab Algoma Steel Corp. Ltd. Sault Ste. Marie, Ont.	F. N. A. Durham Metallurgy Dept. Algoma Steel Corp. Ltd. Sault Ste. Marie, Ont.	R. H. Baber 961 Wellington St. E. Sault Ste. Marie, Ont.
NORTH TEXAS	Stephen Maszy 3968 Spurgeon Fort Worth 15, Tex.	M. J. Condon 9907 Witham St. Dallas 20, Tex.	Delbert Dallefeld 3920 Menzer Rd. Fort Worth 3, Tex.	J. W. Mitchell 4933 Moss Point Rd. Dallas 32. Tex.
NORTHWESTERN PENNSYLVANIA	Ivan C. Marsteller 512 Colorado Dr. Erie, Pa.	Clifford W. Lindquist Grandview Rd. R.D. 1 Oil City, Pa.	Leon R. Maitland 1007 Second St. Meadville, Pa.	
NORTHWESTERN UNIVERSITY—STUDENT GROUP	Robert Wolfson	Lyle Schwartz 7361 N. Greenview Chicago, Ill.	Lyle Schwartz 7361 N. Greenview Chicago, Ill.	

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
NOTRE DAME	George H. Fetherston R.R.1, Box 91 Edwardsburg, Mich.	James L. Beaton 54705 Maple Lane South Bend 15, Ind.	Charles W. Allen Dept. of Metallurgy Univ. of Notre Dame Notre Dame, Ind.	Ettore A. Peretti Dept. of Metallurgy Univ. of Notre Dame Notre Dame, Ind.
OAK RIDGE	H. Inouye 105 Newberry Circle Oak Ridge, Tenn.	E. E. Hoffman Oak Ridge National Lab., Met. Div. Oak Ridge, Tenn.	A. Taboada Oak Ridge National Lab., Met. Div. Oak Ridge, Tenn.	A. E. Goldman Oak Ridge National Lab., Met. Div. Oak Ridge, Tenn.
OLD SOUTH	E. S. Rosenberg 18 Lullwater Rd. Greenville, S. C.	John T. McCormack 210 Wyatt Ave. Clemson, S. C.	B. B. Parks 904 Pendleton St. Greenville, S. C.	R. J. Irwin 202 Rock Creek Dr. Greenville, S. C.
ONTARIO	H. G. Warrington 1 Rosedale Rd. Toronto, Ont., Canada	Victor G. Behal Dominion Foundries & Steel Ltd. Hamilton, Ont., Canada	C. H. Ironberg 56 Pinehurst Dr. Hamilton, Ont., Canada	J. E. Shirreff Johnson Matthey & Mallory Ltd. 110 Industry St. Toronto 15, Ont., Canada
OREGON	W. J. Ulrich, Jr. Pacific Machinery & Tool Steel Co. Portland 14, Ore.	Max Stayton 4100 N.E. Roselawn Portland, Ore.	William H. Rice Electric Steel Foundry Co. 2141 N.W. 25th Portland, Ore.	
OTTAWA VALLEY	John O. Edwards 1247 Amesbrooke Dr. Ottawa, Ont., Canada	N. S. Spence 589 Highland Ave. Ottawa, Ont., Canada	Robert F. Knight Mines Branch 568 Booth St. Ottawa, Ont., Canada	
PENN STATE	Arnulf Muan Dept. of Metallurgy Pennsylvania State University University Park, Pa.	Thomas D. Pasternack Metallurgy Dept. Standard Steel Works Lewistown, Pa.	Kenneth E. Pinnow 1231 S. Allen, Apt. 13 State College. Pa. (Acting Secretary-Treasurer)	
PEORIA	T. W. Peck Knoxville Rd. R.F.D. 2 Peoria 5, Ill.	C. S. Black, Jr. Box 328, 228 Sharon St. Morton, Ill.	John M. St. John 622 Fondulac Dr. E. Peoria, Ill.	
PHILADELPHIA	Frederick Cooper 107 Woodside Ave. Narberth, Pa.	J. B. Giacobbe Skippack, Pa.	Matthew G. Fox 218 E. 3rd St. Media, Pa.	George J. Kaiser Penn. Forge Corp. Milnor & Bleigh Sts. Tacony, Philadel- phia 35, Pa.
PHOENIX	Ralph F. Russi, Jr. Motorola, Inc. 5005 E. McDowell Rd. Phoenix, Ariz.	Warren Travis 5521 W. Clarendon Glendale, Ariz.	Charles W. Mulkin 4607 E. Virginia Ave. Phoenix, Ariz.	Merle C. Nutt 2119 W. Edgemont Ave. Phoenix, Ariz.
UNIVERSITY OF ARIZONA STUDENT GROUP	Dino C. Natta 2331 N. Hampton Tucson, Ariz.	Joseph E. Shirley University of Arizona College of Mines Tucson, Ariz.	Kenneth A. Marcoux 4720 E. Scarlett St. Tucson, Ariz.	James Stokes 2828 E. 20th St. Tucson, Ariz.
PITTSBURGH	Gilbert Soler Universal-Cyclops Steel Corp. Bridgeville, Pa.	Adolf J. Lena Allegheny Ludlum Steel Corp. Brackenridge, Pa.	Earl L. Weaver, Jr. Leeds & Northrup Co. 300 Mt. Lebanon Blvd. Pittsburgh 34, Pa.	R. M. Phillips Aluminum Co. of America New Kensington, Pa.
PUGET SOUND	H. L. Southworth 7027 46th Ave., S.W. Seattle 16, Wash.	Earl C. Roberts 1034 E. 104th St. Seattle 55, Wash.	Mandel Minsk 6029 Oakhurst Rd. Seattle 18, Wash.	

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
PURDUE	E. G. Ridoux 122 Buckworth Dr. Kokomo, Ind.	R. Schuhmann, Jr. School of Chem. & Met. Engrg. Purdue University Lafayette, Ind.	John S. Sabol R. R. 11 Lafayette, Ind.	
QUEBEC	P. H. LaFramboise Aluminum Co. of Canada, Ltd. 400 Blvd. Charest Quebec, P. Q., Canada	Maurice Archambault Dept. of Mines Parliament Bldg. Quebec, P. Q., Canada	Fernand Claisse Faculte des Sciences Universite Lavel Blvd. de l'Entente Quebec, P. Q., Canada	
RHODE ISLAND	Marshall C. Battey 134 Arnold Ave. Edgewood 5, R. I.	Donald J. Davidson M. & C. Nuclear, Inc. P.O. Box 898 Attleboro, Mass.	George H. Schubert 282 Richmond St. Providence 3, R. I.	
RICHMOND	Carson L. Brooks Reynolds Metals Co. Fourth & Canal Sts. Richmond 19, Va.	E. C. Taylor 828 Westham Parkway Richmond, Va.	W. F. Smith Reynolds Metals Co. Fourth & Canal Sts. Richmond 19, Va.	T. S. Daugherty 526 Cherokee Rd. Richmond, Va.
ROCHESTER	Frank J. Gehrlein 151 Hastings Lane Rochester 17, N. Y.	Russel H. Brush 470 Backus Rd. Webster, N. Y.	H. E. Johnson 290 Sunnyside Dr. Rochester 20, N. Y.	
ROCKFORD	R. R. Simonovich Progressive Steel Treating Co. 922 Lawn Dr. Loves Park, Ill.	R. C. Stroker Barber Colman Co. 1300 Rock St. Rockford, Ill.	Joseph P. Sisti Camcar Screw & Mfg. Co. 600 18th Ave. Rockford, Ill.	Robert L. Snygg National Lock Co. 1902 7th St. Rockford, Ill.
ROCKY MOUNTAIN-DENVER	R. F. Schaffer Gardner-Denver Co. P.O. Box 1020 Denver 1, Colo.	N. H. Orr, Jr. Aluminum Co. of America 105 Fillmore St. Denver 6, Colo.	William M. Mueller 2730 Stuart St. Denver 12, Colo.	John L. Golding 3633 Osceola St. Denver 11, Colo.
ROCKY MT.-COLORADO SCHOOL OF MINES	George Kane 2200 Jackson Golden, Colo.	Ted Myers 45 Prospector Park Golden, Colo.	Bob Karlsson 25 Prospector Park Golden, Colo.	S. Bruce Heister SAE House Golden, Colo.
ROCKY MT.-PUEBLO	H. L. Newton 1734 Alexander Circ. Pueblo, Colo	H. E. Wistrand 2202 Balboa Rd. Pueblo, Colo.	Fred E. Newman 2619 7th Ave. Pueblo, Colo.	
SACRAMENTO	E. R. Mertz Aerojet-General Corp. P.O. Box 1168 Sacramento, Calif.	Elliot W. Brady 6820 Burma Rd. Orangevale, Calif.	Joseph J. Warga 2609 Benny Way Rancho Cordova, Calif.	Frank St. Germain Aerojet-General Corp. P. O. Box 1947 Sacramento, Calif.
SAGINAW VALLEY	R. H. Bolt Chevrolet-Saginaw- Transmission Div., G.M.C. Saginaw, Mich.	R. W. Smith Research Engrg. Dept. A.C. Spark Plug Div., G.M.C. Flint 2, Mich.	J. W. Fredrickson Metallurgical Laboratory The Dow Chemical Co. Midland, Mich.	
ST. LOUIS	Robert C. Rueff Nixdorff-Krein Mfg. 916 Howard St. St. Louis 6, Mo.	J. S. Skoglund Lindberg Steel Treating Co. 650 E. Taylor Ave. St. Louis 15, Mo.	A. H. L. Hunnius Carpenter Steel Co. 3942 Laclede Ave. St. Louis 8, Mo.	
SAN DIEGO	S. R. Carpenter 6420 La Jolla Blvd. La Jolla, Calif.	Abraham Hurlich 4648 Marlborough Dr. San Diego 16, Calif.	G. B. Pritchett Solar Aircraft Co. 2200 Pacific Hgwy. San Diego 12, Calif.	P. H. Hausner Ryan Aeronautical Co. Lindberg Field San Diego 12, Calif.

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
SAN FERNANDO VALLEY	Martin H. Binstock Atomics International P. O. Box 309 Canoga Park, Calif.	Saul E. Bramer 7806 Teesdale Ave. N. Hollywood, Calif.	William E. Twiss 2503 N. Ontario St. Burbank, Calif.	George J. Basl 4744 Vista de Oro Ave. Woodland Hills, Calif.
SANGAMON VALLEY	Andrew B. Johnson 33 Berry Dr. Decatur, Ill.	Roy F. Kern Allis-Chalmers Mfg. 3000 S. 6th St. Springfield, Mass.	Louie G. Jones 6 Alice Lane R. R. 4 Decatur, Ill.	Harold Buckholdt 2412 S. 7th St. Springfield, Ill.
SANTA CLARA VALLEY	H. T. Sumsion 4932 Trent Dr. San Jose 24, Calif.	Malcolm M. Davis 5853 Orange Blossom Dr. Los Gatos, Calif.	A. L. Spencer San Jose Die Casting Corp. 815 Chestnut St. San Jose 10, Calif.	John J. Kelly 1828 Valparaiso Ave. Menlo Park, Calif.
SAVANNAH RIVER	R. F. Mittelberg 524 Sisken Circle N. Augusta, S. C.	W. G. Holmes 154 Gilbert St., S. E. Aiken, S. C.	C. W. Mettlen 1249 Evans Rd. Aiken, S. C.	C. L. Selby 504 Tanager Rd. N. Augusta, S. C.
SOUTHEAST OHIO	T. W. Merrill Vanadium Corp. of America P.O. Box 435 Cambridge, Ohio	S. J. Vellenga Muskingum College New Concord, Ohio	A. D. Gate Interlake Iron Corp. Beverly, Ohio	H. W. Rathmann Vanadium Corp. of America P.O. Box 435 Cambridge, Ohio
SOUTHERN TIER	William J. Collins Corning Glass Works Corning, N. Y.	Harry D. Ambs, Jr. International Business Machines Corp. Endicott, N. Y.	Samuel C. Smith American LaFrance Div. Elmira, N. Y.	
SPRINGFIELD	Fred I. Whipple Springfield Heat Treating Co. 99 Margaret St. Springfield, Mass.	L. E. Celender Crucible Steel Co. of America 116 Liberty St. Springfield, Mass.	W. J. Gigowski Chain Belt Co. 369 Plainfield St. Springfield, Mass.	
SYRACUSE	T. A. Crosby Wickham Dr. Brewerton, N. Y.	L. Zakraysek, Jr. 211 Bellwood N. Syracuse 12, N. Y.	R. B. Dudley Hill St. Jordan, N. Y.	T. F. Davis Peter A. Frasse & Co., Inc. P. O. Box 1267 Syracuse 1, N. Y.
TERRE HAUTE	Glen R. Follis Winslow Scale Co. P.O. Box 1198 Terre Haute, Ind.	Kenneth E. Hazledine 231 S. 1st St. Terre Haute, Ind.	Edward A. McLean Rose Polytechnic Inst. Terre Haute, Ind.	Arthur H. Luehring 2215 S. 8th St. Terre Haute, Ind.
TEXAS	William D. Gilder Reed Roller Bit Co. P.O. Box 2119 Houston 1, Tex.	William M. Greer Southwestern Laboratories 1103 Chartres St. Houston, Tex.	LaMar J. Vieau Houston Heat Treating Co., Inc. 2100 Quitman Houston 26, Tex.	
TOLEDO	H. Dean Randolph Toledo Edison Co. Edison Bldg. Toledo 4, Ohio	Robert W. Havens 3841 Surrey Rd. Toledo 13, Ohio	Reynolds S. Shepard 1626 Glenfield Lane Toledo 14, Ohio	
TRI-CITY	John E. Hatch Aluminum Co. of America P.O. Box 750 Davenport, Iowa	John B. Peck 2007 13th St. Moline, Ill.	J. B. Russell Nichols Wire & Aluminum Co. 1725 Rockingham Rd. Davenport, Iowa	
TULSA	Albert B. Marks 3717 E. 43rd St. Tulsa 5, Okla.	John E. Garol 5405 S. Pittsburg Tulsa, Okla.	Dale W. Davis 1806 E. 12th St. Tulsa, Okla.	

CHAPTER	CHAIRMAN	VICE-CHAIRMAN	SECRETARY	TREASURER
UNIVERSITY OF WASHINGTON STUDENT CHAPTER	Larry E. McKnight	Don C. Engdahl	Peter M. Leslie 9902 Second Ave., S. Seattle 8, Wash.	Ray H. Olsen
UTAH	J. M. Carrera 315 E. 2950, N. Provo, Utah	B. R. MacKay 2499 Hartford Ave. Salt Lake City, Utah	Annaleah R. Warner 775 W. 8th, N. Provo, Utah	R. O. Kron 4194 Sunset View Dr. Salt Lake City, Utah
VANCOUVER ISLAND	Matthew F. Gray 401 Widby Lane Sidney, B.C., Canada	James McPherson 120 Sims Ave. Victoria, B.C., Canada	Vernon W. Bowers 2777 Benson Place Victoria, B.C., Canada	John G. Meadley 3015 Dean Ave. Victoria, B.C., Canada
VIRGINIA POLYTECHNIC INSTITUTE	Richard G. Connell, Jr. Box 3096, Virginia Tech Station Blacksburg, Va.	C. Jason Corning Box 3195, Virginia Tech Station Blacksburg, Va.	Theodora Socha Box 5626, Virginia Tech Station Blacksburg, Va.	William H. Hartt, III Box 4027, Virginia Tech Station Blacksburg, Va.
WARREN				
WASHINGTON	William L. Holshouser Room 111, Northwest Bldg. National Bureau of Standards Washington 25, D. C	Richard H. Raring National Aeronautics & Space Admin. 1512 H St., N.W. Washington 25, D. C.	Glenn W. Geil Room 103, Northwest Bldg. National Bureau of Standards Washington 25, D. C.	Henry R. Long Allegheny-Ludlum Steel Corp. 1001 15th St., N.W. Washington 25, D. C.
WEST CENTRAL FLORIDA	William Bolin 2401-50 St., N. St. Petersburg, Fla.	William Lohe 6385 24th Ave., N. St. Petersburg 10, Fla.	Edward Wohlers, Jr. 1650 Robinson Dr., N. St. Petersburg 10, Fla.	
WESTERN ONTARIO				
WEST MICHIGAN	C. E. Laitsch 3540 Reed's Lake Blvd Grand Rapids 6, Mich.	Richard F. Haskins 605 Brookside Dr. Allegan, Mich.	Claude C. Dierdorf Gardner-Denver Corp. Keller Tool Div. Grand Haven, Mich.	
WICHITA	A. L. Paxhia 4230 E. 26th St., N. Wichita 14, Kan.	F. W. Page 3411 E. Skinner Wichita 17, Kan.	Dale Zabel 2922 Hiram Wichita 13, Kan.	Lewis Heiney 635 Fairway Wichita 12, Kan.
WILMINGTON	John Cox, Jr. Experimental Sta. E. I. du Pont Wilmington 98, Del.	Dale Bittinger 11 Marion Ave. Claymont, Del.	Robert O. Bayer 1413 Emory Rd. Green Acres Wilmington 3, Del.	L. M. Nieliwocki 1510 Stoney Run Dr. Northwood Wilmington 3, Del.
WORCESTER	Arthur L. Stowe Vanadium-Alloys Steel Co. Carleton Rd. W. Millbury, Mass.	Harold J. Holmes Heald Machine Co. 14 New Bond St. Worcester 6, Mass.	R. N. S. Merritt, Jr. Olson Manufacturing Co. 100 Prescott St. Worcester 5, Mass.	
YORK				

Minnesota Features Seminar on High-Strength Metals

The **Minnesota Chapter** sponsored its Annual Educational Seminar at the Calhoun Beach Hotel, Minneapolis, Minn., on the theme "High-Strength Metals". The one-day series featured five authorities on high-strength metals plus a showing of the movie, Project Vanguard, by Martin Aircraft Co.

The program showed the why and how of metals used in rocket and missile development. It began with the fundamentals of metal strength, then associated temperature with strength, first with fairly low-temperature steels, up through temperatures associated with molybdenum and tungsten. Then the metals which may show promise in the near future were examined. The program was summarized and future implications of materials development were discussed.

T. L. Johnston, staff scientist, Honeywell Research Center, Hopkins, Minn., spoke on "Fundamentals of the Strength of Metals". He considered the deformation and fracture of metals in terms of the motion and interactions of crystalline imperfections. The effects of grain size, alloying and dispersions on the mechanical properties of metals were discussed. Dr. Johnston explained types of dislocations and showed their relationship to strain hardening and strengthening mechanisms.

R. D. Manning, chief research engineer, alloy steels, U. S. Steel Corp., Monroeville, Pa., talked on "Ultra-High-Strength Steels". Beginning with the background of development and use of high-strength steels, Mr. Manning proceeded with information on 4340, 4335, 300M Strux and X-200 steels, which are the alloys used in aircraft landing gears and at present are finding application in solid propellant missiles. The laboratory development of the ultra-high-strength alloy sheet steel, Airsteel X-200, was described, and its characteristics, properties, methods of productions and applications were discussed.

George C. Deutsch, chief, Refractory Materials Branch, National Aeronautics and Space Administration, Cleveland, covered "The Strength of Tungsten and Molybdenum in the Temperature Range of 2500 to 4500° F." The apparatus and techniques which have been developed to conduct physical tests in the temperature range of 2500 to 4500° F were described. Data was presented on various compositions of tungsten and molybdenum alloys. The factors affecting the strength and ductility of these alloys and possible methods for improving these properties were also discussed.

D. J. McPherson, director, metals research, Armour Research Foundation, Chicago, discussed "Potentials and Problems of the Newer Metals". Some of the "newer" metals show promise to supply unfulfilled needs in low-density, high-strength applications, extremely high-temperature service and special nuclear environments. Light weight and high strength to moderate temperatures may be provided by beryllium, titanium, vanadium or zirconium alloys. Heat resistance beyond the present superalloys seems possible with vanadium chromium, columbium, molybdenum, tantalum or tungsten. Improved structures for special nuclear environments will be provided by beryllium, zirconium, columbium or vanadium alloys. Most of these metals are extremely reactive with air at high temperatures, while some of them may be quite brittle at room temperature. The hopeful metals, their potential uses and problems, were discussed individually.

William S. Pellini, superintendent, U. S. Naval Research Laboratory, Washington, D. C., described "Implications of Space and Hypersonic Flight on Materials Development". He described the variety of new problems presented to the metallurgist in the application of materials to high-speed flight, re-entry and space flight vehicles. The temperature attained by the skin of the aircraft depends not only on the temperature of the hot boundary layer gases but also on the emissivity characteristics of the skin. Re-entry heat problems, as typified by nose cones, involve extreme temperatures beyond the temperature limits of known materials if radiative equilibrium is established. The short-time pulse heat flux conditions associated with re-entry provide for solutions based on absorbing the heat by diffusion to a heavy wall heat sink or by ablation. Space flight systems, such as satellites, are involved with heating due to radiation from the sun. Temperature control of the skin is attained by the use of coatings featuring an exact balance between reflectivity in the visible portion of the sunlight spectrum and emissivity in the infrared.

High-flame temperatures 4500 to 7000° F. of both solid and liquid rocket motors require special cooling devices for the nozzles. Solid propellant nozzles may be cooled by the use of heat sink principles. Mr. Pellini emphasized that specific thermal protection systems must be designed for specific conditions of heat flux and time. Also the materials field should recognize that thermal protective systems represent sophisticated use of materials in combination to obtain a "least weight" solution to thermal problems.—**Reported by Kenneth L. Quigley for Minnesota.**

Speakers at the Educational Seminar on "High-Strength Metals" Sponsored by the Minnesota Chapter Included, From Left: T. L. Johnson, Honeywell Research Center, R. D. Manning, U. S. Steel Corp., D. J. McPherson, Armour Research Foundation, W. S. Pellini, U. S. Naval Research Laboratory, G. C. Deutsch, National Aeronautics and Space Administration, and K. L. Quigley, Seminar Chairman

Indiana Symposium on Metallurgy for the Space Age

The seven Indiana Chapters of the American Society for Metals, Purdue, Terre Haute, Fort Wayne, Calumet, Muncie, Notre Dame and Indianapolis, recently cooperated to present the Annual Spring Symposium, entitled "Metallurgy for the Space Age". Purdue was the sponsoring chapter. More than 200 members and guests attended the program.

Allen G. Gray, editor of *Metal Progress,* served as technical chairman. Speaking of the problems encountered in space technology, Dr. Gray pointed out that we are fighting a materials war. In order to overcome these problems, we must utilize known materials and extract further properties from them.

Shown Is the Team That Combined Its Talents to Make the Annual Symposium of the Indiana Chapters on "Metallurgy for the Space Age" One of Its Most Successful Ventures. Included, from left, are: L. R. Frazier and L. D. Richardson, speakers; C. T. Leaman, Purdue chairman; A. L. Hurst, symposium chairman; D. D. Wyatt and C. L. Faust, speakers; and A. G. Gray, editor, Metal Progress, *technical chairman*

Lloyd Richardson, chief, Research and Technical Development Branch, Materials Laboratory, Wright Air Development Center, Loring Frazier, metallurgy research and development laboratories, Metals Hydrides, Inc., Charles Faust, chief, Electrochemical Engineering Division, Battelle Memorial Institute, and D. D. Wyatt, National Aeronautics and Space Administration, were the speakers.

Role of Metals in the Space Age

Lloyd D. Richardson

Recognizing the fact that material requirements are much further ahead than capabilities, materials have come to be "the key to superiority in astronautics".

The problem of weight reduction, for example, posed additional problems, such as uniformity and reliability. To cope with these problems, the designer, engineer and scientist developed the concept of a materials system. The "materials system" may be defined as "a combination of two or more reasonably homogeneous materials which provides a capability of a higher order than that exhibited by any one component of the combination acting alone". Examples of such systems are adhesive bonded honeycomb sandwiches, ceramic coated sheet metals, fiber reinforced plastics and metal reinforced insulating ceramic coatings.

A materials program can never be truly forward-looking if it has as an objective only the meeting of clearly defined and current problems. Rather, it must be aimed at unfolding new possibilities and meeting anticipated requirements.

The earth's atmosphere must be penetrated at least twice if a space vehicle is to be recovered on earth. To return safely to earth without injury to man or components requires that the vehicle divest itself of its potential and kinetic energy by retro-firing rockets or by some drag device. Aerodynamic heating has prompted the intensive study on ablating materials. Film clips of the ablating process on different materials were shown by Mr. Richardson.

Since the ratio of fuel plus structural weight to useful payload is so high, practically no material which will do the job at reduced weight can be eliminated on the basis of cost alone. If it can be obtained or developed, it must be used!

In view of aerodynamic heating and the terrific power required to push a vehicle through the atmosphere, it is logical to get above the atmosphere and utilize centrifugal lift for long-time, long-distance and high-speed operations. This is the realm of astronautics. Some of the natural environments which will be encountered in space operations are: very high vacuum, solar radiation, ozone, dissociated and ionized gases, auroras, cosmic rays and meteoric particles. Some or all of these may demand advanced materials technology. Induced environments in space which may be important from the materials standpoint include temperature, acceleration, vibration, shock, nuclear radiations and zero gravity.

Based on these known conditions of outer space, the alloys of aluminum, magnesium, titanium and iron, for which there is considerable technology and production capability, are proving and should continue to prove useful for skins, pressure vessels and other stressed parts.

An accelerated research and development program is underway to fully exploit the good potentials exhibited by the refractory metals, columbium, molybdenum, tantalum and tungsten, and the refractory nonmetallics (ceramics), beryllium and graphite. These materials will challenge the ingenuity of the metallurgist and materials engineer to solve the associated problems of poor oxidation resistance, low ductility (beryllium), and of fabrication into useful structural shapes.

Metal Powders in Missile and Rocket Fuels

L. R. Frazier

In order for a material to be suited for use as a rocket fuel, it must satisfy numerous conditions: high energy, light weight, physical and chemical control and stability, gas generation and minimum residue. Certain metal powders meet these requirements and are thus suited for space travel propulsion.

The generation of energy per unit weight is most important in space-age applications. Several elements possessing these combined properties are boron, aluminum, hydrogen and magnesium. There are a number of different physical forms in which powders can be used: of these the simplest is a powder slurry. Combinations of several powders with liquid hydrocarbons give the best energy-weight ratio. However, the utilization of such liquid fuels is hampered by the necessary use of pumps and controls. This demand has been eliminated by the solid fuels, which are controlled by composition

(*Continued on p.* 16)

and texture. Unfortunately, the solids are unstable in storage unless protected by resins.

Physical controllability and stability are of utmost importance. To achieve usage as fuels, metal powders must be fine particles. The particles may be utilized in either a liquid or gaseous suspension. These suspensions must be highly stable against temperature changes and chemical changes due to storage aging. Another problem is particle size uniformity. Without uniformity, inefficient burning results.

Rocket fuels must generate gases to develop the necessary forces for flight. The gases expand and leave the exit nozzle at high velocities. Some metal powders which vaporize upon oxidation are likely to be cooled to liquids or solids by heat radiation. Others would not expel themselves from the combustion zone.

Residue left by burning fuels is a great problem. Metal powders are particularly troublesome in this respect, often changing the size and shape of exit passages.

Flammability of metal powders is greatly affected by composition, size distribution, particle shape and surface condition, oxidant availability, dispersion and temperature. All of these properties are interrelated, and if only a few are met, flammability is almost certain.

Composition and particle size are the primary factors in flammability. Certain metals are more combustible than others, although all powders are comparably flammable at low particle sizes. Oxidation of surface becomes increasingly greater for the finer particles, thus rendering them useless. Oxygen availability has a great effect upon combusion. Some fuels generate additional oxygen in the burning process. Relating all of the above conditions for flammability is the temperature effect. Under suitable conditions, temperature can modify those properties to increase or decrease flammability.

These difficulties, along with the problems of residue formation, must be overcome by the metal powder industry in order to apply the powders to space-age fuels.

Protective Metallic Coatings

Charles L. Faust

Surface deterioration can prevent the successful use of metals that have high-temperature strength. One solution to the problem is a metallic coating, the choice of which is determined by the following factors:

1. Oxidation and/or corrosion resistance
2. Thermal stability
3. Thermal expansion
4. Diffusion alloying with basis metal
5. Melting point of coating and of diffusion zone.

From the metallurgical viewpoint, protective coatings impose an interest in composite materials wherein the outer layer is chosen to protect the stress-carrying metal underneath. The properties of the composite are important. The success or failure of a coating to protect may depend on the interfacial zone between the basis metal and the coating. This zone, controlling bond strength and adherence, has three parts: (1) basis metal skin; (2) the first layer of coating; and (3) an intermediate layer of alloy formed by the diffusion of coating and skin.

In high-temperature service, oxygen and other gases are the cause of failure. Proper reaction and diffusional characteristics of a coating are important. Equally important, however, the coating must stay in place, a condition critically dependent on the basis metal skin provided by surface preparation.

Surface preparation includes metallurgical cleanliness, which is a relative measure of the distortion, tearing, smearing and strain on the surface. "Smoothness", even to 3 to 5 microin., is open to question. Photographs of such surfaces magnified 10,000 × appear as plowed fields. Metallurgically these skins are weak compared to the properties of the bulk metal. Mechanical means of finishing, such as grinding, machining and buffing, will produce this weak skin and present an unsound foundation for the coating. The investigation of electropolished surfaces shows that the removal of distorted metal presents a skin which has strength properties approaching those of the bulk metal.

Dr. Faust discussed many of the metallic coating methods, such as hot dipping, vacuum evaporation, vapor phase plating, chemical reduction, electroplating and spraying. One or more of these methods, along with the choice of coating and proper surface preparation, provides surface stability that will tolerate rapid and intense heating.

The Conquest of Space

D. D. Wyatt

Peoples of the world, although about to embark on the "Space Age", nevertheless do not know much about the universe and its workings. United States space projects to increase this knowledge can be divided into four parts: scientific studies; civilian applications of space; manned space flight; manned exploration of space. In all of these nonmilitary spheres, the United States program is more developed than conmmonly realized.

The purely scientific programs will concentrate on the physical nature of the immediate space in which we live. The composition of the earth's atmosphere will be one primary objective. It is known that the primary driving force in the atmosphere is solar energy. Whereas convection currents provide principle mixing of the atmosphere at low altitudes, other phenomena, such as chemical dissociation and particle mixing, predominate at extreme altitudes. Chemical changes in such constituents as oxygen changing to ozone and to atomic oxygen are believed to be important upper atmosphere factors. The ionosphere will also be an important objective of study. Not only are the ionospheric bands of fundamental interest but directly affect radio communications.

Another little-understood field is that involving high-energy particles, such as cosmic rays. From where do they come? Great advances have recently been made in this field with the discovery of the Van Allen belts, donut-shaped layers of highly charged particles surrounding the earth. Other basic scientific questions involve magnetic, electric and gravitational fields. Is there magnetism on the moon? How does gravity propagate? Is Einstein's theory valid?

We can learn more about the answers to these phenomena by sending sounding rockets, satellites and space probes from the earth. Such testings provide a vertical cross section, and time and position variations of space. In this way, we hope to be able to discover the surroundings of the earth.

Civilian applications studies will be carried out in several areas. Meteorological satellites will be used to obtain measurements of temperature, heat balance, cloud cover and important atmospheric constituents. Communication satellite systems of a passive nature, using inflated reflecting spheres, and of an active nature, using airborne receiver-transmitters, will be launched to explore the feasibilities of such systems.

Manned space flight will initially be accomplished using a ballistic capsule for vehicle. The initial flights will enable us to learn something about the behavior of a man in space conditions and will help us develop technology for space flight. Later objectives will include the launching of satellite space laboratories and eventually manned flights to the moon and, at a much later date, nearby planets.

Great improvements will have to be made in the vehicles to be used for these ventures. Present vehicles are largely adapted ballistic missiles. Future vehicles designed for space flight, are now being developed. Contracts exist for single engines delivering up to one and one-half million pounds of thrust. Vehicles having take-off up to six million pounds of thrust will be developed using these engines.

Scientific knowledge to be acquired in the space program may be expected to extend into and affect all areas of life. If the last 50 years could be termed "exciting", the next 50 years cannot be adequately described. — **Reported by G. E. Kleinedler and J. D. Clyne for Purdue.**

G.E. Sets Record

The fifth class of General Electric Co. personnel to complete a Metals Engineering Institute course in the past two years received diplomas at graduation exercises held in June. The diplomas were presented by W. Cashin, manager of Materials Development Operation.

The class, consisting of 20 G.E. people, mostly technicians from the metallurgical and chemical laboratories at the Knolls Atomic Power Laboratory, operated by G.E. for the Atomic Energy Commission, finished the tailor-made course, "Fundamentals of Metallurgy", composed of selected lessons from several M.E.I. courses, in 18 two-hour sessions.

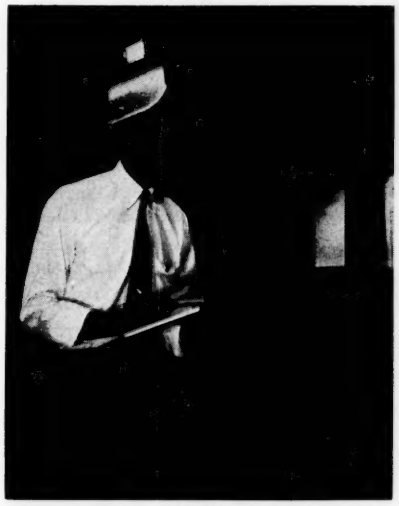
The course was so well received by all concerned, including the students, the education office, and the managers of the men who were enrolled, that application has been submitted to the Atomic Energy Commission to put it on as a permanent course.

First Arc Welding Graduate

W. Theodore Highberger, physical metallurgist at the U. S. Naval Proving Ground, Dahlgren, Va., has the distinction of being the first home-study student to complete the Metals Engineering Institute course entitled "Arc Welding".

Mr. Highberger graduated from the College of Wooster (Ohio) in the field of mathematics and indicated that he considered the M.E.I. course

METALS ENGINEERING INSTITUTE NEWS



W. T. Highberger

an excellent one. The "Arc Welding" course, he reported, was helpful in his work at Dahlgren, where he is associated with the welding of ordnance components. He plans to enroll in "Stainless Steels" next.

Mr. Highberger studied about two to four hours per week and completed one of the 15 lessons on "Arc Welding" every two weeks. The course was prepared under the direction of Clarence E. Jackson, staff engineer at the Linde Air Products Co., Newark, N. J., and is proving to be a very popular course.

This fall over 1000 technicians, metallurgists and administrators will enroll for metallurgy courses with the Metals Engineering Institute.

Present indications are that enrollments via chapter-sponsored extension classes will quadruple and enrollments via company-sponsored in-plant training programs will more than double. Individual enrollments are also expected to increase significantly.

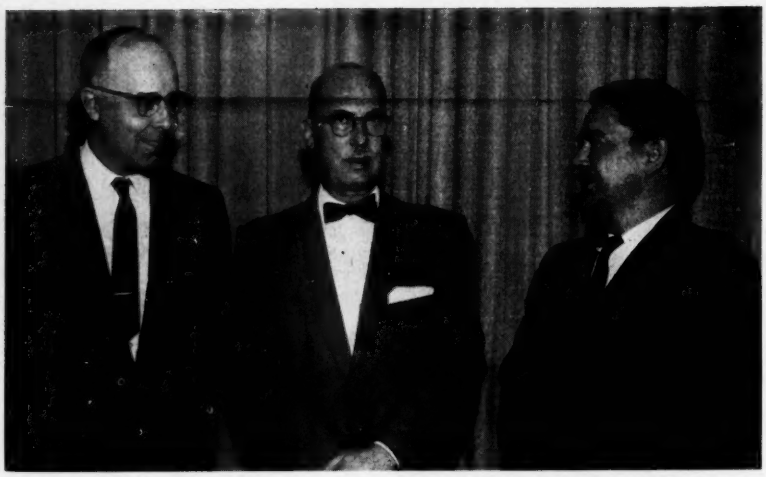
At present, the beginning course, Elements of Metallurgy, is by far the most popular, with approximately half of M.E.I.'s students enrolled in this course. Second in popularity is Heat Treatment of Steel, third High-Temperature Metals. A surprisingly large number of students have enrolled in Electroplating and Metal Finishing, fourth in popularity, with Stainless Steels, Metals for Nuclear Power and Copper, Brass and Bronze, close behind. Foundry Practice and Arc Welding are about of intermediate popularity at present.

New courses now being readied, Principles of Machining, Corrosion, Principles of Heat Treating and Welding Fundamentals, will probably challenge the front runners in the M.E.I. "hit parade".

METALS ENGINEERING INSTITUTE IS ON THE MOVE

(For additional information on M.E.I., see p. 34)

General Electric Personnel Who Received Diplomas for Completing the M.E.I. Course "Fundamentals of Metallurgy" Included, From Left, Standing: Mr. Cashin, W. Owczarski, Instructor, L. Tranter, E. Bush, M. Reiter, D. Kittle, J. Colopinto, J. Erickson, S. Toftegaard, E. Manderville, W. Clark, R. Lachthrupp and R. Beach, and seated, from left: A. McMaster, G. McKenna, J. Curatolo, T. Hannum, H. Tymchyn, J. Noonan, G. Powell, R. Selzer and A. Andrako



Shown at a Meeting in Montreal Are, From Left: R. Thompson, Chairman; W. Glover, Canadian Pratt & Whitney Aircraft Co. Ltd., Who Spoke on "Plating and Finishing"; and Andre Hone, Councillor for the Chapter

Speaks on Plating and Finishing At Montreal

Speaker: W. Glover

Canadian Pratt & Whitney Aircraft

Members and guests of the **Montreal Chapter** heard a talk on "Plating and Finishing" by W. Glover, chemical planner, Canadian Pratt & Whitney Aircraft Co. Ltd.

Mr. Glover outlined the development of the electroplating industry, starting with its inception in 1801 when Brugnatelli gilded pennies by power from a voltaic cell. This was preceded by discoveries in 1789 of contact electricity by Luigi Galvani, and of the voltaic cell in 1799 by Volta. From then on the industry developed continuously through the efforts of such people as Watts, Daniels, Elkington and Jacobi. The introduction of the first direct current rotating generator in 1844 gave real impetus to the industry.

At the turn of the century, the need for more scientific and technical knowledge became more and more pressing. The National Electroplaters Association was formed in 1909, this became the American Electroplaters Association in 1913. Electrodeposition to salvage worn parts was used during the World War I and has been extensively used since. Considerable developments have taken place in the last 20 years. One of the major improvements is the use of rectifiers as power sources. The rectifier is known to be more flexible and to require lower maintenance costs.

Electroplating is used to improve appearance, wear and corrosion resistance, change the coefficient of friction, produce a base for soldering and coating, for masking in carburizing and to change dimensions.

In designing parts which are to be electroplated, consideration should be given to recessed portions which are difficult to reach by plating because of the limitations of the throwing power of a bath. A part may be plated in some particular region by masking off or by wrapping the area to be plated with a bag holding the electrolyte. For proper plating of parts racking must also be well designed so as to insure uniformity of deposition.

Surface preparation is of utmost importance in electroplating. The polishing wheel and belt are used to remove metal, just as a milling cutter. The fine luster on some metals is produced by the use of a cloth wheel with tripoli polish, limes and rouges. The condition of the base metal on which another metal is deposited influences the character of the deposit. The type of polishing also influences the corrosion resistance of the metal deposited.

Metal cleaning prior to plating is also very important. All harmful foreign materials have to be removed, otherwise the deposit may not adhere sufficiently well to the base metal. Cleaning may be carried out by chemical or electrolytic action. Rinsing following the cleaning operation must be closely controlled.

Nickel and chromium may be easily produced with either bright or ordinary luster. Chromium is deposited for decorative purposes as a very thin layer over bright nickel and copper. High-strength steel parts that are chromium plated should be baked so as to remove hydrogen and hence relieve the parts from stresses and hydrogen embrittlement. — **Reported by Andre Hone for Montreal.**

President Meets Scholarship Winners

The 1959 and Two Previous A.S.M. Foundation Scholarship Winners Were on Hand at the Formal Presentation of the 1959 Award to George A. Sloan, North Carolina State College, by A.S.M. President C. H. Lorig. Shown are, from left: Dr. Lorig; W. W. Austin, head of the department of mineral industries, North Carolina State College; Martin L. Tyson, the 1957 winner; W. N. Rankin, the 1958 scholarship winner; and Mr. Sloan

Outlines Developments in Radioisotopes

Farno L. Green (Left), General Motors Corp., Research Staff, Spoke on "The Development of Radioisotopes for Metallurgical Research" at Saginaw Valley. He is shown with William C. Keesaer, technical chairman

Speaker: F. L. Green
General Motors Corp.

Members of the **Saginaw Valley Chapter** heard a talk on "The Development of Radioisotopes for Metallurgical Research" by Farno L. Green, senior research physicist, General Motors Corp., Research Staff, in which he described recent work in developing new low-energy radioactive isotopes as useful sources in the radiography of metals.

Mr. Green outlined the program sequence in four basic areas:

1. The prudent selection of potentially valuable isotopes.
2. Finding economic ways to procure chosen materials.
3. Adequate determination of their nuclear characteristics.
4. Demonstrating their industrial potential through actual plant applications.

There has been a long-standing unfilled industrial and medical need for radioisotopes which emit pure gamma or X-radiation in the range from 5 to 150 Kv. Ideally, these should have half-lives of six months or longer and must be economically obtained with high specific activity. Such materials are potentially valuable for the radiography and thickness gaging of low-density materials and thin sections of high-density materials, which generally are of great interest to the automotive industry.

The necessity for adequate laboratory effort to determine the nuclear characteristics of these isotopes was emphasized. Although meager published data is in existence, it is not always wise to consider this data reliable, particularly as applied to the rare earth isotopes.

Isotopes specifically mentioned as possibly economically useful sources for radiography were samarium-145, samarium-153 and gadolinium-153. The properties, nuclear characteristics and schemes of decay were discussed and radiographs of both industrial and medical subjects were used to illustrate the potential application of these radioisotopes.—**Reported by William C. Keesaer for Saginaw Valley.**

Sangamon Valley Launches Chapter

Officers of the Newly Formed Sangamon Valley Chapter, Which Includes the Springfield, Decatur and Champaign, Ill., Area, Include, From Left: W. M. Norton, Program Chairman; Andrew B. Johnson, Chairman; Dale J. Wright; Speaker From the Peoria Chapter; Harold Buckholdt, Treasurer; and Louie Jones, Secretary. Roy F. Kern, vice-chairman, was unable to attend this meeting, during which the 51 members elected the above officers and planned the technical and educational program for the coming technical season. (Reported by C. F. Gebhardt for Sangamon Valley)

A.S.M. Books Exhibted

A number of books published by the American Society for Metals were on display at the week-long Metals Seminar of the National Association of Waste Material Dealers, held at Michigan State University, East Lansing, Mich.

Some 100 junior executives of the secondary metals industry were enrolled in the Seminar. They had an opportunity to examine the books, set up as a library display, and also heard a lecture on "Sources of Information" which discussed these, as well as other important books as part of the literature on metals.

Among the books on display were: Man, Metals and Modern Magic, by J. Gordon Parr; Engineering Alloys by Norman E. Woldman; and the A.S.M. Metals Handbook, edited by Taylor Lyman. Other A.S.M. books recommended in a published bibliography were: Copper and Copper Alloys, by O. W. Ellis; Magnesium; The Story of Magnesium, by W. H. Gross; and Stainless Steels, by Carl A. Zapffe. Also on display was the magazine, *Metal Progress,* published by A.S.M.

Electric Arc Steelmaking Is Subject at Pittsburgh

Speaker: Dennis J. Carney
U.S. Steel Corp.

D. J. Carney, division superintendent, steel production, U. S. Steel Corp., Duquesne Works, presented a talk on "Large Electric Arc Furnace Steelmaking Experience in the United States" at **Pittsburgh Chapter's** Sustaining Members' Night.

Melting steel in electric furnaces first started in 1906. In 1910, there were nine furnaces in operation producing 0.3% of the total production. Little expansion was evident until World War II when the demand of increased melting capacities, along with limited capital investment, resulted in a sharp rise in their use. Initial furnaces were rather small and restricted for melting of high-quality steels. Development of larger furnaces and reduced operating costs were instrumental in competitive application of the electric furnaces to carbon steel melting. Development of top charging practices in 1925 significantly contributed to construction of larger furnaces. Our country had 239 electrics in 1946, all being restricted to 70 tons. The first 200-ton furnace was successfully operated in 1954. Since the end of World War II, continued developments by steelmakers have resulted in operation of 31 furnaces in the range of 70 to 200 ton capacities. A 250-ton furnace has been tentatively designed with six electrodes and an elliptical hearth.

Steelmakers who have used electric furnaces for carbon steel have continually directed their efforts toward reduced operating costs in efforts to compete with the openhearth. Elimination of delays was mandatory. A 20% increase in production was predicted when hot metal charging was first used in 1957. This increase has not as yet been realized; however, continued experience should help achieve this goal. Hot metal is added in amounts of 20 to 40%, either after a small pool forms under the electrode, or at a later period when a larger quantity of the scrap has been melted. The excessive boiling first encountered when using hot metal has been overcome by increased use of oxygen. Greater hearth area has also minimized boiling. Improved practices and larger furnaces have resulted in an output of 25 to 34 tons per hr. in 1957 compared to the 1952 output of 13 to 18 tons per hr. A stainless steel producer is reportedly melting stainless in a 200-ton furnace averaging 18 to 20 tons per hr. Dr. Carney indicated the optimum hot metal practice for carbon steels has as yet not been developed.

The Battelle Institute report, issued several years ago, evaluated the economics of electric and openhearth furnaces, indicating that hot metal charging was better in the openhearth while cold metal favored the electric furnace. The economic aspect of electric furnace melting is very favorable when considering the initial investment is 50% less than the openhearth. Smaller size buildings and auxiliary equipment attract those with limited capital when building new installations. Cost of charged material varies considerably for cold and hot charging. Availability of scrap is never sufficient in any country over a long period: consequently, hot metal charging increases as the availability of scrap decreases.

Dr. Carney recently visited a number of European countries to observe their steelmaking facilities. He discussed the practices used in England, Belgium, Russia and Germany as compared to those used in the United States.—**Reported by V. E. Demski for Pittsburgh.**

Panel Covers Cutting Metals

Members of a Panel Which Discussed "Cutting Metals Over 60 Rockwell-C" at a Meeting in Hartford, Included, From Left: L. E. Selfridge, Sheffield Co., L. P. Tarasov, Norton Co., and E. J. Weller, Metallurgical Products Department, General Electric Co., and Moderator H. Hubbell

L. Edward Selfridge, sales engineer, machine tool sales, Sheffield Co., E. J. Weller, specialist, cutting tool sales, Metallurgical Products Department, General Electric Co., and Leo P. Tarasov, research associate, Research and Development Department, Norton Co., formed a panel to discuss "Cutting Metals Over 60 Rockwell-C" at a meeting held recently by the **Hartford Chapter.**

The discussion was led by Henry Hubbell, chief metallurgist, Fafnir Bearing Co., who acted as moderator.

With the aid of slides and exhibits, the speakers presented basic data pertinent to each method of cutting metals over 60 Rockwell-C. Mr. Weller emphasized the "Application of Carbide and Cemented Oxide Cutting Tools", Dr. Tarasov cited the case for "Diamond Wheel Grinding Low-Grindability Steels" and Mr. Selfridge presented a discussion on "Ultrasonic Machining".

The meeting was concluded with a question and answer period which, in general, pointed out the relative areas of usefulness for each method. —**Reported by R. D. Burge for Hartford Chapter.**

Reviews Use of Statistical Methods in Steel Technology

Speaker: J. W. W. Sullivan
American Iron and Steel Institute

John W. W. Sullivan, American Iron and Steel Institute, technical speaker at a recent meeting of the **Syracuse Chapter,** gave a talk entitled "Statistical Methods in Steel Technology".

Mr. Sullivan's talk concerned the use of statistical methods in studying variability in some of the processes and products of the steel industry. Variability is always present in manufacturing, and statistical methods, by themselves, cannot control variability. They merely reveal significant numerical relationships, involving comparison with standards or other reference data. Actual control of variability is accomplished by doing something or refraining from doing something to the raw materials, manufacturing operations and production personnel on the basis of information revealed by the statistical methods.

Mr. Sullivan presented four case histories in which modern statistical methods were used in the control of variability.—**Reported by G. Trojanowski for Syracuse.**

Rockets, Mass Ratios And Space Flight Are Described at Ottawa

Speaker: H. Preston-Thomas
National Research Council-Canada

H. Preston-Thomas, Division of Applied Physics, National Research Council, Ottawa, gave a talk entitled "Rockets, Mass Ratios and Space Flight" at **Ottawa Valley.**

Dr. Preston-Thomas first reviewed some basic equations relating to rocket propulsion (the only practical means of space travel at our disposal at present). Ignoring frictional effects, the characteristic final velocity V_c of a rocket in free flight is given by:

$$V_c = V_e \ln\left(\frac{M_o}{m}\right)$$

where V_e is the velocity of the exhaust gases, M_o the total initial mass of the rocket and m its final mass. The ratio M_o:m is known as the "mass ratio". If the exhaust velocity is fixed, an increase in V_c can only be achieved by a relatively large increase in the mass ratio (owing to the logarithmic nature of the equation) and this results in the total weight of the rocket increasing at the expense of its payload.

The exhaust velocity of a rocket powered by chemical fuel is given by the following equation:

$$V_e = \sqrt{\frac{2\gamma}{\gamma-1} \cdot \frac{R\theta}{M}\left\{1-\frac{P_o}{Pl}\right\}^{\frac{\gamma-1}{\gamma}}}$$

where γ is the average ratio of the specific heats of the exhaust gases, θ their temperature, M their average molecular weight and P_i and P_o are, respectively, the maximum pressure and exit pressure of the exhaust gases. R is the gas constant.

Of the variables in this equation, only the temperature and the molecular weight seem to offer possibilities for significant increases in exhaust velocity. At present the temperature is limited by the properties of available materials to about 3000° K.

The exhaust gas from ordinary chemical reactions with the lowest molecular weight is water (plus excess hydrogen) ($M \sim 8$), and with a temperature of 3000° K. the exhaust velocity is about 3.5 km/sec. Such values, assuming the use of multistage rockets, has proved sufficient for escaping from the earth for which a characteristic velocity of 11 km/sec. is required. For journevs from orbit, to the moon and back to orbit (for which a characteristic velocity of about 16 km/sec. is required) the mass ratio for an exhaust velocity of 3.5 km/sec. is so high as to be considered impractical.

It is possible, that with further improvements in technique, exhaust velocities might be increased to 5 or even 6 km/sec. For example, in nuclear rockets now being investigated elsewhere, the average molecular weight of the exhaust gases will be reduced by the use of hydrogen as the propellant. However, it seems that journeys to the outer planets in reasonable times are not possible with chemical rockets and would be difficult with nuclear rockets.

Much higher exhaust velocities can be obtained by the use of:

(a) the ion rocket, in which ions are accelerated to high velocities by electromagnetic means;
(b) the plasma rocket, in which an ionized gas carrying an electric current is repelled by the other conductors in the circuit.

By these methods it is easy to obtain exhaust velocities of the order of 200 km/sec. for the ion rocket and 50 km/sec. for the plasma rocket, which would enable a high characteristic velocity to be obtained more efficiently than in a chemical rocket. Although the power of these rockets would probably not be sufficient for escape from the earth, they would be useful for the comparatively slow release of energy required on long interplanetary journeys.

Probable sources of power for these rockets would be nuclear and solar. In this connection, Dr. Preston-Thomas pointed out that it is in the power source that difficulties are likely to be experienced with plasma and ion rockets as, in contrast with chemical rockets, the rocket motors themselves will probably not present many problems.

Summarizing, Dr. Preston-Thomas considered that a typical interplanetary journey would take place in six stages:

1. Into orbit round the earth by means of a chemical or nuclear rocket;
2. From orbit round the earth to orbit round the planet by means of ion or plasma rocket;
3. Landing on the planet by aerodynamic braking;
4. Escape from planet into orbit round it by chemical or nuclear rocket;
5. Return to orbit round earth by plasma or ion rocket;
6. Land on earth by aerodynamic braking.

—Reported by W. A. Pollard for Ottawa Valley Chapter.

Cold Forging Discussed at Canton

James F. Leland, Assistant Sales Manager, Parker Rust Proof Co., Discussed "Cold Forging Operations" at a Canton-Massillon Meeting. Shown are, from left: W. W. Scheel, chairman; Mr. Leland; and G. J. Linck

Speaker: J. F. Leland
Parker Rust Proof Co.

A talk entitled "Cold Forging Operations" was presented before members of the **Canton-Massillon Chapter** by James F. Leland, assistant sales manager, Parker Rust Proof Co.

Mr. Leland stated that, in the past, the various methods of compression forming were looked upon as costly operations due to the high pressures required. Actually, many items formerly machined or produced by some other means are now being formed much more economically by some method of compression forming.

Both the automobile and press companies have become attracted to compression forming and are investigating several methods.

The advantages claimed by the speaker for the different methods of compression forming were listed as follows: A cheaper base material can be used, such as hot rolled rod; little or no scrap is generated; machining is either reduced or eliminated completely; labor costs are reduced; surface finishes are greatly improved; close tolerances can be kept; and physical properties are improved.

With the aid of slides, the speaker defined and explained various terms used in the cold forming field including coining, backward extrusion, forward extrusion, ironing and upsetting. Various aspects of lubrication and tool design were also discussed.

Many smaller companies today are moving into this field, and the only factor preventing faster development is the lack of qualified engineers to promote this business.— **Reported by George Matthews for Canton-Massillon Chapter.**

Reviews Heat Treating Distortion

Norman O. Kates, Chief Metallurgist, Lindberg Steel Treating Co., Presented a Talk on "Minimizing Heat Treating Distortion" at a Meeting in Indianapolis. Shown are, from left: Sam Morhan and Homer Smitha, both from Allison Div., General Motors Corp.; George J. Shubat; and Mr. Kates

Speaker: N. O. Kates
Lindberg Steel Treating Co.

N. O. Kates, chief metallurgist, Lindberg Steel Treating Co., spoke on "Minimizing Heat Treating Distortion" at a meeting of the **Indianapolis Chapter.**

Distortion is a metal cancer, particularly for heat treaters. With the increased demands of modern products, pressure has increased to produce parts free from distortion. Factors contributing to distortion are:

1. Steel expands when heated and contracts thermally on quenching. Differential geometry may expand and contract at varying rates.
2. When steel is hardened, the austenite is more dense than martensite; hence a complex combination of movement when the steel is heated and cooled.
3. Hot steel is weak; cold steel is more resistant to change.

Warpage is caused by: unbalanced design; keeping temperature gradient down to a minimum; machining—unequal removal of metal; nonuniform heating in the furnace; and cooling.

Here design affects rate of cooling with thick and thin sections. Quality tools and gears can be kept free of distortion by efficient equipment; selection of steel (thorough knowledge of TTT curves); and method of quenching—heavy sections should enter quench first, and agitation of quench is most important for uniform quenching. Mr. Kates had many slides to illustrate the points he made.—**Reported by Dorothy Holbrook for Indianapolis.**

Dr. Lorig Guest at Los Alamos

National President C. H. Lorig and His Wife Were Recently Guests at a Meeting of the Los Alamos Chapter. Dr. Lorig spoke on "Material Selection Today". Shown are, from left: W. W. Martin, chairman; Mrs. Lorig; Dr. Lorig; Mrs. Martin; and M. C. Smith, technical chairman of the meeting

Compliments

To A. F. HOLDEN, president of the A. F. Holden Co., who received an A.S.M. 25-year certificate at a recent meeting of Detroit Chapter.

♦ ♦ ♦

To JOHN C. FISCHER, physicist at the General Electric Research Laboratory, who received an award from A.S.T.M. for "his contributions to the knowledge of the fundamentals of metals, and his leadership in metallurgical research". Dr. Fischer delivered the Horace W. Gillett Memorial Lecture on "The Role of Dislocations in Plastic Deformation".

♦ ♦ ♦

To JOHN HERBERT HOLLOMON, manager of the Metallurgy and Ceramics Research Dept., General Electric Research Laboratory, and national trustee, A.S.M., on being elected a fellow of the American Academy of Arts and Sciences.

♦ ♦ ♦

To W. F. ALDERSON, past chairman of Kansas City Chapter, on his new position as senior test engineer for American Car & Foundry's Erco Division, Albuquerque. Mr. Alderson had been employed by G.M.C. for the past ten years.

♦ ♦ ♦

To J. H. WESTBROOK, metallurgist, General Electric Research Laboratory, on being awarded the Richard L. Templin Award of the A.S.T.M. for his outstanding paper, "Microhardness Testing at High Temperature".

♦ ♦ ♦

To GEORGE O. HIERS, consulting metallurgist (retired, National Lead Co.), MARY R. NORTON, metallurgist, Ordnance Materials Research Office, and HERBERT W. STUART, director of quality control, United States Pipe & Foundry Co., on receiving A.S.T.M.'s Awards of Merit, which are awarded to leaders in the field of engineering materials who have given outstanding service to the Society.

♦ ♦ ♦

To ROBERT J. MACDONALD, R. L. CARLSON, and W. T. LANKFORD, who were awarded A.S.T.M.'s Dudley Medal for their paper, "The Effects of Strain Rate and Temperature on the Stress-Strain Relations of Deep-Drawing Steel", judged as an outstanding original contribution on research in engineering materials.

♦ ♦ ♦

To JOHN B. RITTENHOUSE, Jet Propulsion Laboratory, California Institute of Technology, on receiving A.S.T.M.'s Sam Tour Award, given to encourage research in corrosion testing methods, for his paper "The Corrosion and Ignition of Titanium in Fuming Nitric Acid".

New Films

The Green Drum

Vanadium Corp. of America has released "The Green Drum", a 23-min., 16-mm., sound and color film which tells the story of ferroalloy production from the mining of the ore to the shipment and utilization of the finished product. Order from: Public Relations Div., Hazard Advertising Co., Inc., 444 Madison Ave., New York 22, N. Y.

Industrial Material Handling Catalog

The Material Handling Institute, Inc., 1 Gateway Center, Pittsburgh 22, Pa., has issued a booklet, "Industrial Material Handling Films", which reviews 63 films available through member companies.

Machine Tools

The National Machine Tool Builders' Assoc. has produced a film, "One Hoe for Kalabo", a 27½-min., 16-mm., sound and color movie dealing with the theme that machine tools have made today's civilization possible. It is available through Modern Talking Pictures Service, Inc., 3 East 54th St., New York 22, N. Y.

Refining Copper From the Sudbury Nickel Ores

A 39-min., 16-mm. sound and color movie, which tells the intricate story of copper refining, can be ordered from The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Resistance Welding Films

Three new 16-mm., color and sound films on resistance welding are available from the Resistance Welder Manufacturers' Assoc., 1900 Arch St., Philadelphia 3. They are: "This is Resistance Welding", its sequel "Resistance Welding" and "Resistance Welding of Stainless Steel".

Hydraulic Engineering

Hydraulic vane-type pumps are discussed in "Power-Up" and axial piston pumps in "Design for Power", both 16-mm., sound and color films available from Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio.

Tour Aluminum Plant

Twenty-nine members and three guests of the **Richmond Chapter** visited the extrusion plant of the Reynolds Metals Co. during a meeting held recently. They followed the extrusion process from the molten metal to the finished part. The visit was followed by dinner at the Holloway House and an informative talk on baseball by Jack White, business manager of the Virginians, Richmond's representatives in the International League.—**Reported by Patrick H. Woods for Richmond.**

Describes Large Ingot Vacuum Casting

"Vacuum Casting of Large Ingots" Was the Subject Discussed by Michael V. Herasimchuk, Bethlehem Steel Co., at a Meeting of Northwestern Pennsylvania Chapter. Shown are, from left: I. C. Marsteller, vice-chairman; W. W. Lynch, Jr., chairman; Mr. Herasimchuk; and Lawrence G. Hauser

Speaker: Michael V. Herasimchuk
Bethlehem Steel Co.

Michael V. Herasimchuk, metallurgical supervisor, Bethlehem Steel Co., spoke on "Vacuum Casting of Large Ingots" at a meeting of the **Northwestern Pennsylvania Chapter.**

Mr. Herasimchuk opened his talk with a description of the occurrence of hydrogen in basic electric steel. Dissolved hydrogen, although it is present only in what seems to be small quantities, is responsible for "flaking", a condition which has caused failures of large forgings in the past. Because of the rapid development of sonic testing equipment, flaking which would have gone undetected a few years ago is now being detected. Vacuum degassing has been developed as a means of extracting the undesirable hydrogen from the melt and thereby eliminating flaking.

Several systems have been used for vacuum degassing but the most common is the stream degassing method used at Bethlehem Steel Co. This system consists of a small pony ladle which sits on top of an evacuated tank which houses the ingot mold. Heat from the molten steel in the pony ladle melts an aluminum rupture disk and the steel runs into the ingot mold. The stream coming out of the pony ladle breaks up into a spray and hydrogen and other gasses are removed by the vacuum. Steam ejectors are used to create pressures of less than 1000 microns in the tank. Accurate instrumentation is a problem in vacuum degassing and for this reason reported pressures may vary considerably from one company to another.

Vacuum degassing has been very successful with large ingots. The hydrogen content has been greatly reduced and the flaking virtually eliminated. Ductility and cleanliness also have greatly improved. Numerous other benefits have been reported and it is expected that the surge toward vacuum degassing in the heavy forging industry will soon be extended to other areas of steelmaking.—**Reported by R. W. Henderson for Northwestern Pennsylvania Chapter.**

Speaks on Vacuum Steam Degassing

Kendrick C. Taylor, Manager, Vacuum Steam Degassing, F. J. Stokes Corp., Presented a Talk Entitled "Modern Variations in Vacuum Degassing Techniques" at a Meeting of New Haven Chapter. Shown are, from left: A. J. Blank, technical chairman; Mr. Taylor; and K. L. Tingley, chairman

At Cleveland Chapter's Panel Meeting

Members of the Panel, Appropriately Identified, Which Discussed "Casting Versus Forging Versus Welding" at a Meeting Held at the Cleveland Chapter, Are Shown With Keith J. Humberstone, Chairman of the Chapter

"Casting Versus Forging Versus Welding" was the subject of the **Cleveland Chapter** panel meeting held recently. M. L. Frey of Allis-Chalmers was moderator.

Panel members were: Jerry Fingerhut, Thompson Products, Inc., J. F. Snider, Goodyear Aircraft Corp., W. K. Hunt, John Deere Harvester Works, William Edwards, North American Aviation, Inc., K. B. Valentine, Pontiac Motors Division, G.M.C., and George Kappelt, Bell Aircraft Corp.

Panel members discussed several specific cases, giving reasons why a decision had been made to use one of these three methods as opposed to another where more than one method could produce required engineering properties. Slides and actual parts were used as illustrations for the discussion.

By invitation on return cards sent out with the meeting announcement, a number of questions and specific parts were submitted by members of the audience for discussion by the panel and to obtain their ideas on how these specific parts could be most economically made.

Castings versus weldments for machine tool bases was discussed at some length by the panel members and participants from the audience.

The moderator entertained other questions from the audience after written questions had been discussed.

OBITUARIES

GEORGE L. MCKAIN, member of A.S.M. for more than 30 years, died Feb. 8, 1959.

♦ ♦ ♦

LOUIS F. HALLER, associate professor in charge of Mineral Technology Extension at The Pennsylvania State University and secretary-treasurer of the Penn State Chapter, died May 4, 1959. Prof. Haller helped to start A.S.M.'s Metals Engineering Institute home study courses.

♦ ♦ ♦

LOYAL G. TINKLER, metallurgical engineer, Vanadium Corp. of America, until his retirement in 1958, died May 7 at age 65.

♦ ♦ ♦

RONALD W. THOMPSON, sales engineer for Transue & Williams Steel Forging Corp. and frequent contributor to the A.S.M. Metals Handbook, died at Miami Beach, Fla., at age 60.

♦ ♦ ♦

MARVIN J. UDY, vice-president and consultant for Strategic-Udy Processes, Inc., died of a heart attack in April. Dr. Udy developed and patented many plating and extraction processes, including the first commercial processes for the refining and utilization of chromium.

♦ ♦ ♦

JOHN C. LINCOLN, 92, founder and president for 22 years of the Lincoln Electric Co., died May 26, 1959. He was a pioneer in the development of ductile welds and held more than 50 patents for electrical appliances. ALTON F. DAVIS, vice-president and secretary for the Lincoln Electric Co., also died May 26 at age 69. He established the most extensive welding library in the world—the A. F. Davis Welding Library. In 1954 he was presented the Samuel Wylie Miller Medal by the American Welding Society for his contributions to welding education.

♦ ♦ ♦

JAMES T. MACKENZIE, member of Birmingham Chapter and past trustee, A.S.M., died Nov. 19, 1958.

♦ ♦ ♦

BENJAMIN F. EDDIE, A.S.M. Life Member, died Mar. 9, 1959. He was a member of the St. Louis Chapter.

Effect of Vacuum Steam Degassing Topic at Utah

Speaker: M. A. Orehoski
U. S. Steel Corp.

A talk on the "Effect of Vacuum Stream Degassing on Properties of Forging Steels" was presented at a meeting of the **Utah Chapter** by M. A. Orehoski, U. S. Steel Corp., Applied Research Laboratory.

Mr. Orehoski covered the equipment and procedure for vacuum casting of large forging ingots weighing as much as 240 tons. A four-stage steam ejector system proved effective in maintaining the absolute pressures below 800 microns at pouring rates of more than 8 tons per min.

Mr. Orehoski stated that investigation of large forgings has indicated that the vacuum-casting process reduces the hydrogen content in most steels to less than 1 ppm., deoxidizes some steels, the amount of oxygen removed being related to the composition of the steel, reduces the sensitivity to thermal flaking and improves tensile ductility.

Mr. Orehoski adequately illustrated the talk with numerous slides and photographs of equipment used in the process that has been installed at U. S. Steel's Duquesne Works.—**Reported by L. D. Scott for Utah.**

Talks on History of Extrusion

G. M. Young, Immediate Past President A.S.M., Talked on the "History of the Extrusion Process" at a Meeting of Northwestern Pennsylvania Chapter, and Brought the Members Up-to-Date on Headquarters Activities. At the meeting, from left, were: W. W. Lynch, Jr., chairman; Mr. Young; L. R. Maitland, program chairman; and Ivan C. Marsteller, vice-chairman

Describes Research at G.M.'s Technical Center

Speaker: D. J. Harvey
General Motors Corp.

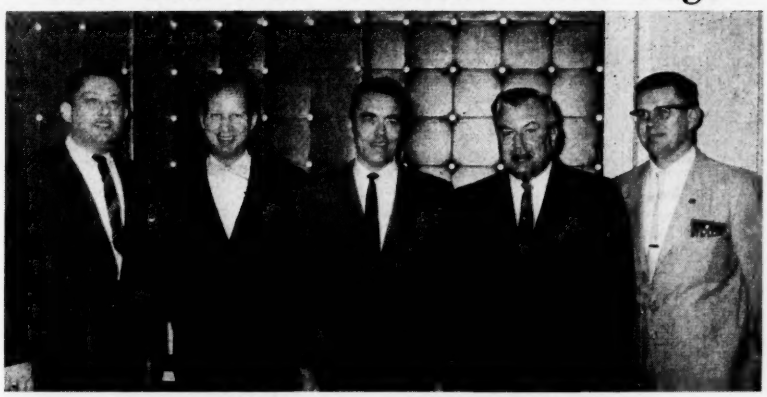
Douglas J. Harvey, senior research metallurgist, Metallurgical Engineering Department, General Motors Corp. Research Laboratories, spoke at a joint meeting of the **Saginaw Valley Chapters** A.S.M. and A.W.S., on "Research at the General Motors Technical Center". He illustrated his talk with slides of the modern buildings and landscaping at the Technical Center.

The Technical Center is primarily devoted to long-range research problems that the various divisions of General Motors are unable or unequipped to handle themselves. There are four basic groups at the Technical Center—Styling, for design of General Motors products; Engineering Staff, for advance engineering developments (also vehicle safety, standards and technical operation of the proving grounds, etc.); Process Development, methods of manufacture and inspection; and Research Laboratories, applied and fundamental research in fuels and lubricants, physics, electronics, atomic energy, metals, etc.

Manufacturing and engineering research buildings and a technical library with over 35,000 volumes are located at the Center for its personal and other divisions use.

Dr. Harvey concluded with a discussion of some of the activities of the metallurgical research group, including studies in wear resistance, corrosion testing, alloy development, processing, nuclear reactive materials and one of his own fundamental research projects on surface tension and wetting phenomenon.—**Reported by H. E. Gillihan for Saginaw Valley.**

Past Chairmen Honored at Oak Ridge



Past Chairmen of the Oak Ridge Chapter Were Recently Guests of Honor at a Meeting During Which M. A. Scheil, National Trustee A.S.M. Spoke. Present were, from left: W. D. Manly and D. A. Douglas, Metallurgy Division, Oak Ridge National Laboratory; W. O. Harms, University of Tennessee; L. K. Jetter, Oak Ridge National Laboratory; and W. T. Carey, Union Carbide Nuclear Co. (Photograph by A. P. Litman for Oak Ridge Chapter)

Speaker: M. A. Scheil
A. O. Smith Corp.

Merrill A. Scheil, director of metallurgical research, A. O. Smith Corp., and national trustee A.S.M., spoke on "The Effect of Aging Treatments on the Corrosion Resistance of Austenitic Stainless Steels" at a meeting of **Oak Ridge Chapter.**

Since the advent of carbide stabilizers and low carbon contents, it has been possible to fabricate such steels without greatly affecting the intergranular corrosion resistance. The effect of time and temperature on these parameters has not yet been fully explored. Using Types 347, 304L and 316L as examples, the speaker explained the corrosion resistance changes induced by aging at 700-1500° F. for times up to 10,000 hr. He pointed out that the Huey test, though quite severe, is useful in determining the corrosion resistance of these materials because it reveals sensitization when chromium carbide and sigma phase are precipitated at the grain boundaries. The Streicher test, sulphuric acid buffered with ferric sulphate, is less severe and may prove very useful.

Mr. Scheil illustrated time-temperature relationships with graphs, showing the contours of various corrosion levels as functions of time and temperature. In general, Type 347 had a higher corrosion rate after 1000 hr. at 900° F. and after 100 hr. at 1000° F., with the rate decreasing after 3500 hr. at 1000° F. Type 304L showed high corrosion rates between 350 and 1000 hr. at 900° F. and between 35 and 100 hr. at 1000° F. Type 316L had a high corrosion rate in the 1200-1300° F. range but rather low up to 10,000 hr. at 900° F.

Further testing after a stabilizing heat treatment of 1650° F. for 2 hr. markedly improved the resistance of Type 347 but had no effect on Types 304L and 316L.

Mr. Scheil concluded with the statement that the investigation had resulted in the development of time-temperature sensitization diagrams that were different for each material tested. Further work may reveal the possibility of characterizing each type of stainless steel by using such diagrams.—**Reported by A. Goldman for Oak Ridge.**

Saginaw Grants Scholarship Awards

Shown During the Meeting at Which Final Selection of the 1959 Saginaw Valley Scholarship Award Winners and Their Alternates Were Made, Are, From Left: Rodney V. Johnson, Flint, Recipient of a $250 Award; Stephen L. Cranfield, Davison, Second Alternate; James G. House, Chairman, Educational and Student Affairs Committee; Frederick A. Harris, Bay City, First Alternate; and Robert C. Ruhl, Saginaw, Recipient of the $500 Award

A.S.M. created the Annual Teaching Award in Metallurgy, open to teachers of metallurgy in the United States and Canada. Value $2000.

EMPLOYMENT SERVICE BUREAU

The Employment Service Bureau is operated as a service to members of the American Society for Metals and no charge is made for advertising insertions. The "Positions Wanted" column, however, is restricted to members in good standing of the A.S.M. Ads are limited to 50 words and only one insertion of any one ad. Address answers: c/o A.S.M., Metals Park, Novelty, Ohio, unless otherwise stated.

POSITION OPEN

South

PHYSICAL METALLURGIST: Large shipbuilding corporation engaged in building nuclear powered ships requires services of a physical metallurgist experienced in welding metallurgy. Lab experience and experience with stainless steel and other corrosion resisting materials desired but not essential. Send resume to: Ingalls Shipbuilding Corp., Pascagoula, Miss.

Southwest

MECHANICAL ENGINEERS: To design, build or sell air cooled heat exchangers. Should be familiar with mechanical drives, both electrical and hydraulic, have some knowledge of fans and air movement and a general idea of heat transfer. Also should have working knowledge of structural fabrication and design. Engineering degree with some practical experience required. Location: Beaumont, Tex. Send resume and salary requirements in confidence to: G. Y. Taylor, Administrative Services, Alco Products, Inc., Schenectady 5, N. Y.

Midwest

METALLURGIST: Opportunity to grow with progressive, multi-plant investment casting organization. Foundry experience and training in nondestructive testing, gating and/or vacuum casting of high-temperature alloys desirable. Good future for capable man. Box 8-15.

METALLURGICAL ENGINEER: Young B.S. graduate for position in metallographic laboratory in automotive manufacturing research and development activity. Experience in ferrous and nonferrous metallography preferred. Report writing ability essential. Excellent opportunity for advancement in general metallurgical fields. Salary commensurate with experience and background. Send resume of education, experience and salary desired. Box 8-20.

POWDER METALLURGIST: College-trained metallurgist or chemist with approximately five years experience in conventional powder metallurgy, to take charge of raw materials specifications, process and product quality control activities in recently re-organized powdered metals plant. Modern metallurgical laboratory. Salary commensurate with training and experience. Box 8-25.

DESIGN ENGINEERS: To test industrial springs, prepare specifications and methods of tests. Detail springs on inquiries and orders, revise specifications to allow more efficient manufacture, assist customers with design of springs to meet specifications. Engineering degree with some experience in spring design required. Location: Chicago Heights, Ill. Send resume and salary requirements, in confidence, to: G. Y. Taylor, Administrative Services, Alco Products, Inc., Schenectady 5, N. Y.

SERVICE METALLURGICAL ENGINEER —STEEL MELTING: Attractive opening for metallurgical service engineer to do liaison work between technical center and customer steel plants dealing with carbon and low-alloy steels. Applicant should have melting shop experience. Opportunity to participate in technical and research developments and commercial trade problems. Metallurgical engineering degree desirable. Salary commensurate with qualifications and experience. Apply to: H. S. Schaufus, Chief Metallurgical Engineer, Vanadium Corp. of America, Research Center, Cambridge, Ohio.

SERVICE METALLURGICAL ENGINEER —NONFERROUS: Opportunity for nonferrous metallurgist interested in customer technical service and development work. Applicant should be familiar with aluminum and titanium alloys manufacture and use. Degree desirable. Salary open. Apply to: H. S. Schaufus, Chief Metallurgical Engineer, Vanadium Corp. of America, Research Center, Cambridge, Ohio.

TEACHER OF METALLURGY: Excellent opportunity on staff of expanding school of engineering available Sept. 1, 1959. Rank and salary based on qualifications. Address: E. J. P. Fischer, Head, Dept. of Metallurgical Engineering, Youngstown University, Youngstown, Ohio.

METALLURGISTS: Detroit commercial heat treating firm has rare opportunity. If you have administrative and executive ability, a metallurgical degree and are under 40, with professional experience using atmospheres in heat treatment of ferrous and exotic alloys along with supervisory and/or sales experience, send complete resume to: Box 8-30.

METALLURGIST: With basic steel mill experience, familiar with electric steel melting and rolling, for development and control work in rapidly growing alloy steel bar mill. Excellent opportunity for advancement. Box 8-35.

MECHANICAL ENGINEER (Tool Engineer): With research experience for supervising research in the punching of sheet steels. Salary commensurate with training and experience. Large research laboratory, Pitts-

METALLURGISTS

ENGINEER—M.E. or I.E.

N.D.T. ENGINEER

Challenging opportunities for outstanding men to work in modern Quality Control organization with progressive and expanding company. Other metallurgical positions are also available. Many personal and professional benefits. Send complete resume, in confidence to:

Technical Vice-President
Latrobe Steel Co.
Latrobe, Pa.

METALLURGIST required by progressive and expanding company manufacturing specialized chemical products for the foundry industry. Applicants should preferably be under 35, possess a metallurgical degree, and have had several years experience in foundry work; thorough knowledge of casting defects, metallography and photography is essential. The successful applicant will be employed in the Service Laboratory. The position offers excellent prospects of advancement and good starting salary will be paid. Applicants should submit a resume of qualifications to:

FOUNDRY SERVICES, INC.
P. O. Box 8728
Cleveland 35, Ohio

METALLURGISTS

Metallographer to interpret microstructures of ferrous and nonferrous metals and work on electron microscope.

Nonferrous metallurgist to work on the application of aluminum and aluminum alloys to the auto industry.

Physical metallurgist to produce intermetallic compounds.

Write: Chrysler Corp.
Engineering Division
Box 1118
Detroit 31, Mich.

burgh area. Forward complete resume and salary requirements to: Box 8-40.

West

SENIOR AND JUNIOR METALLURGISTS: To plan, direct, carry out materials research and development in the nuclear field. Opportunities exist for both applied and basic work in new laboratory. Currently in progress are programs in thermal stress fatigue, alloy development, high-temperature properties, fuel element development, ceramic coating techniques and properties. An advanced degree and/or experience in the nuclear field would be desirable. Send resume to: Dean W. Townsend, Advanced Technology Laboratories, Division of American-Standard, 369 Whisman Rd., Mountain View, Calif.

POSITIONS WANTED

TUBE MANUFACTURING MANAGER: With 25 years experience in manufacturing, research and development, technical control, process, methods, production, brazing, welding, plug and mandrel drawing, terne-coating, galvanizing of steel tubing, welded tube production. Wants responsible challenging position as plant manager, assistant plant manager or assistant to president. Box 8-45.

SALES ENGINEER: Steel mill, warehouse or commercial heat treater, with 18 years diversified experience in all types of heat treating, laboratory and production supervision. Two years college, business administration. 38 years old, family. Will relocate in Michigan, Wisconsin or Illinois only. Box 8-50.

METALLURGIST: M.S. degree, age 36, family. Seven years experience with same automotive manufacturer including product and process control of heat treating, alloy fixturing, furnace atmosphere generation, specifications, production development, special quenches and stabilization procedures. Desires more challenging position, preferably research. Resume on request. Will relocate Midwest, Southwest. Box 8-55.

TECHNICAL INFORMATION SPECIALIST: B.S. in chemistry, B.S. in library science, desires information position with research and development organization. Has 25 years experience in organizing and operating information services in fields of metallurgy, physics, engineering and electronics. Familiar with problems in handling reports, documents and journals. Box 8-60.

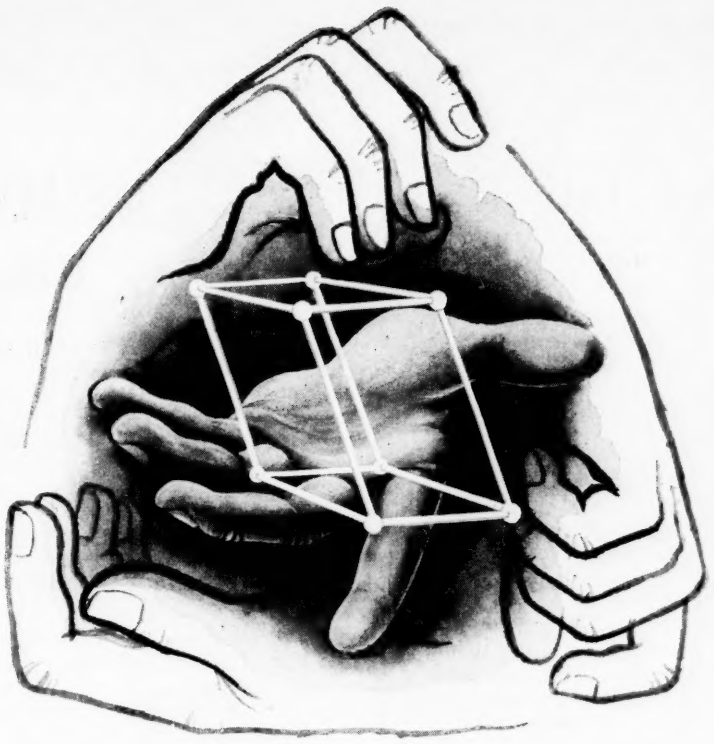
DEVELOPMENT METALLURGIST: B.S. degree (honor student) age 27, family, professional references. Six years experience in development of high-temperature structural alloys for jet engine industry, five years with leading jet engine manufacturer, one year with producer of high-temperature alloys. Child's illness makes relocation in Southern California imperative. Prefers senior specialist position, development laboratory. Box 8-65.

METALLURGICAL ENGINEER: B.S. degree, early 30's, veteran, family. Over six years in high production iron foundries, in-

METALLURGIST

M.S., Ph.D., preferably with five years experience in heavy steel industry. Must have thorough working knowledge of basic openhearth and electric furnace steel melting and hot working operations. Should have strong interest in physical chemistry of steelmaking and in physical metallurgy. The position involves research and development in deoxidation and desulphurization of iron and steel. Plant located on Texas Gulf Coast. Please send complete resume to

Box 8-5, Metals Review



TO A
METALLURGIST'S
METALLURGIST

If your knowledge and interests are in the complex area of reactor core material development and fabrication, then you will be interested in the Atomic Power Department of Westinghouse, where your ability to solve the problems involved in this aspect of nuclear technology will play an important part in the overall effort to make atomic power available to all of industry. At Westinghouse you will be able to apply creative metallurgy to a research or development problem and follow it through from beginning to end. Here, you will have the pleasure of associating with the foremost authorities in the field of industrial nuclear technology and the satisfaction of knowing that you continue where others stop.
Working at the Atomic Power Department will enable you to take advantage of what has been called the Renaissance City of America—Pittsburgh. Here, the evidence of the atomic age is strikingly present by the number of world renowned research centers devoted to nuclear science. In addition to all of this, you have the advantages of gracious suburban living.

SENIOR METALLURGIST . . . Minimum of three years in reactor field preferably in materials application or materials irradiation. To study the changes resulting from irradiation in the properties of reactor core materials.

METALLURGIST . . . With at least one year in reactor core materials technology field. Materials development for fuel element prototypes. Testing and evaluation of fabrication methods for fuel elements.

Send resumé to Mr. C. S. Southard, Westinghouse Atomic Power Dept., P.O. Box 355, Dept. W-24, Pittsburgh 30, Pa.

Westinghouse
FIRST IN ATOMIC POWER

The 14th METALLOGRAPHIC EXHIBIT

Chicago, November 1 to 6, 1959

All metallographers—
everywhere—
are cordially invited to
display their best work.

RULES FOR ENTRANTS

Exhibitors do not need to be members of the American Society for Metals.

Work which has appeared in previous metallographic exhibits held by the American Society for Metals is unacceptable.

Photographic prints should be mounted on stiff cardboard, extending no more than 3 in. beyond edge of print in any direction; maximum dimensions 14 by 18 in. (35 by 45 cm.). Heavy, solid frames are unacceptable.

Entries should carry a label on the *face of the mount* giving:

Classification of entry.

Material, etchant, magnification.

Any special information as desired.

The name, company affiliation and postal address of the exhibitor should be placed on the *back of the mount* together with a request for return of the exhibit if so desired.

Entrants living outside the United States should send their micros by first-class letter mail endorsed "Photo for Exhibition—May Be Opened for Customs Inspection".

Exhibits must be delivered before Oct. 15, 1959, either by prepaid express, registered parcel post or first-class letter mail, addressed:

Metallographic Exhibit
American Society for Metals
53 W. Jackson Blvd.
Chicago 4, Ill., U.S.A.

CLASSIFICATION OF MICROS

Class 1. Cast irons and steels
Class 2. Carbon and alloy steels (wrought).
Class 3. Stainless steels and heat resisting alloys.
Class 4. Aluminum, magnesium, beryllium, titanium and their alloys.
Class 5. Copper, nickel, zinc, lead and their alloys.
Class 6. Uranium, plutonium, thorium, zirconium and reactor fuel and control elements.
Class 7. Metals and alloys not otherwise classified.
Class 8. Series showing transitions or changes during processing.
Class 9. Welds and other joining methods.
Class 10. Surface coatings and surface phenomena.
Class 11. Slags, inclusions, refractories, cermets and aggregates.
Class 12. Electron micrographs.
Class 13. Results by unconventional techniques.
Class 14. Color prints in any of the above classes. (No transparencies accepted.)

AWARDS AND OTHER INFORMATION

A committee of judges will be appointed by the Metal Congress management which will award a First Prize (a medal and blue ribbon) to the best in each classification. Honorable Mentions will also be awarded (with appropriate medals) to other photographs which in the opinion of the judges closely approach the winner in excellence. A Grand Prize, in the form of an engrossed certificate and a money award of $500 from the Adolph I. Buehler Endowment will also be awarded the exhibitor whose work is judged best in the show, and his exhibit shall become the property of the American Society for Metals for preservation and display in the Society's national headquarters.

All prize-winning photographs will be retained by the Society for one year and placed in a traveling exhibit to the various Chapters.

41st NATIONAL METAL CONGRESS & EXPOSITION

INTERNATIONAL AUDITORIUM — — — CHICAGO — — — NOV. 1 to 6, 1959

RESEARCH METALLURGISTS

The J&L Research Division wishes to add to its staff in 1959 several professional metallurgists, to broaden the scope of the Corporation's research programs in carbon and stainless steels.

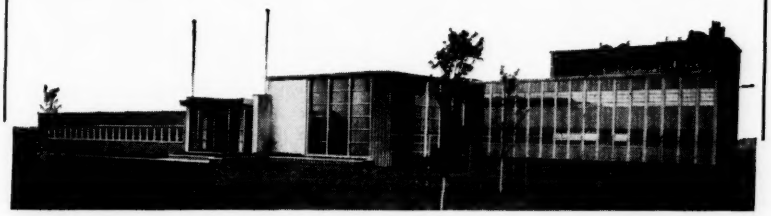
Of specific interest are physical metallurgists (Ph.D., or M.S. with related research experience) to conduct projects in high-temperature materials, alloy development, corrosion, general applied physical and mechanical metallurgy.

Several openings exist also for recent B.S. graduates, in the fields described above and in projects dealing with steelmaking process analysis and development. For the B.S. graduate interested in a permanent research career, Pittsburgh offers unmatched opportunity for continued education at the graduate level.

J&L is fourth-largest in the United States steel industry, making a wide variety of carbon and stainless steel products. The Research Division is located in modern facilities in suburban Pittsburgh.

JL STEEL

Send resume, in confidence, to John A. Hill
Research and Development Department
Jones & Laughlin Steel Corporation
3 Gateway Center, Pittsburgh 30, Penna.



PHYSICAL METALLURGISTS

Opportunities for creative industrial research in new, fully equipped non-ferrous Metals Research Laboratory in New Haven, Connecticut.

Access to facilities of major university.

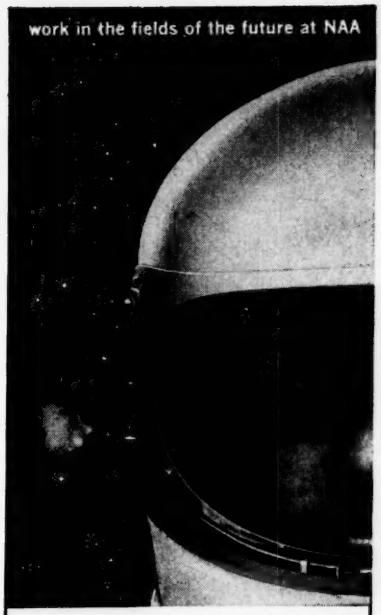
Pleasant living in New England cultural and recreational center.

Career positions available for fundamental and applied research in the physical metallurgy of aluminum-base alloys.

Ph.D. or equivalent required. Experience in the technology of aluminum desirable.

Send detailed resume to:

E. R. Patterson, Employment Manager
Olin Mathieson Chemical Corporation
New Haven, Connecticut



PHYSICAL METALLURGISTS

Join one of industry's most progressive teams in exploring the metallurgical frontiers of supersonic flight.

Here are unusual opportunities in applied research for experienced metallurgists who would like to assume increased responsibility and expand their "sphere of influence."

Successful applicants must have the ability to organize and direct the work of others. These positions afford exceptional opportunities for advancement in an expanding materials development program.

Background Preferred: Graduate Metallurgical Engineer with at least four years experience including development or application work in one or more of the following specialties:

Titanium Alloys
Hot Work Die Steels
Superalloys
Refractory Metals
Mechanical Metallurgy
(Sheet Metal Forming)

For more information please write to: Mr. V. H. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

PHYSICAL METALLURGIST
or
METALLURGICAL ENGINEER

B.S. with minimum five years manufacturing experience.

Well versed in heat treat techniques and procedures for ferrous and nonferrous metals. Capable of specifying metals and treatment to specific use. Should be familiar with welding, machining and finishing.

Capable of handling metallurgical aspects of oil well equipment manufacturing plant. Location Southwest.

Salary open. All replies confidential. Send complete resume to

Box 8-10, Metals Review

PHYSICAL METALLURGIST For alloy development at project responsibility level. The work will be in nonferrous and precious metal specialties for electrical, electronic, and chemical applications and in brazing alloys. An advanced degree, or BS with excellent academic record plus 3 to 5 years research experience, is desired. Excellent opportunity for a creative man in a sound, moderate sized, growing company. Send resume to

Metallurgical Department
Handy and Harman
Bridgeport 1, Connecticut

CORROSION ENGINEER

Opportunity for challenging work in corrosion control at the world's most modern refinery. Prefer young man with degree in metallurgy or chemical engineering and up to three years' experience. Background in refinery or corrosion problems desirable but not essential. Write

Employee Relations Department
TIDEWATER OIL COMPANY
Delaware City, Delaware

METALLURGISTS—CHEMISTS

B.S. — M.S. — Ph.D.

To study dissolution of intermetallic compounds, reaction mechanisms and develop etches for investigation of crystal perfection and microstructure. Study special etching problems on semiconductor materials. Experience and training in surface chemistry desirable but not essential.

M. F. McConkey
Industrial Relations—Dept. 819
WESTINGHOUSE RESEARCH LABORATORIES
Beulah Road, Churchill Borough
Pittsburgh 35, Pennsylvania

---

cluding experience as melting supervisor and metallurgist. Over two years experience in research with stainless steels and high-temperature alloys. Interested in career position utilizing background with possibilities for growth. Box 8-70.

METALLURGIST: B.S. and M.S. degrees, age 39, experienced in applied research and development covering melting, casting and heat treatment of gray, white and ductile irons, carbon and alloy steels, toolsteels, stainless steels and certain nickel alloys. Desires position commensurate with experience. Minimum salary $15,000. Box 8-75.

NUCLEAR FUELS DEVELOPMENT: B.S. degree in physical chemistry with graduate training. Four years development experience on nuclear ceramic fuel as project engineer. Development work on investment casting, shell molding and magnetic materials. Three years experience in extrusion and molding. Desires position with expanding company in research or development. Box 8-80.

METALLURGIST: Recent M.S. in metallurgy, diversified experience in research and troubleshooting, heat treating, welding, forging, casting and other fabricating problems of both ferrous and nonferrous materials. Establishment of metallurgical production control standards and purchase specification of materials and equipment. Investigation and determination of product service failures. Cost analysis of alternate processes and materials. Box 8-85.

METALLURGIST: M.S. degree with some business courses, age 34, veteran, married. Eight years industrial experience with ferrous and nonferrous materials. Supervisory category in research and development. Interested in responsible position in high-temperature field of administrative nature. Will relocate. Box 8-90.

PHYSICAL METALLURGIST: Ph.D. degree, several years teaching and research experience at undergraduate and graduate levels, desires university appointment. Interested in imperfections, diffusion and nuclear metallurgy. Any location considered, prefers West, Southwest or Northeast. Age 30, married. Box 8-95.

METALLURGIST: B.S. degree, age 43, married, with 18 years experience in the following fields: 10 years investment casting of ferrous and nonferrous materials as plant manager and development metallurgist; 6 years in aircraft supervision of metallurgical and X-ray laboratories; two years ordinance, metallographic, X-ray, physical testing and study of foreign ammunition troubleshooting and consultant work relating to brazing, welding, heat treating, casting, forging and forming. Box 8-100.

MAKE A DATE
FOR DALLAS

Second Southwestern Metal Exposition and Congress Will be Held in

Dallas . . .
May 9-13, 1960

METALLURGICAL ENGINEER: B.S. or M.S. degree with one to five years experience in development and fabrication of nonferrous and ferrous material. Must have good understanding of fundamental metallurgy concerning metallography, heat treatment and ability to read and interpret specifications and instructions. Compile and evaluate data, and recommend necessary changes. Send resume to: Employment Section, ACF Industry, P. O. Box 1666, Albuquerque, N. Mexico.

Metals for Supersonic Aircraft and Missiles

New ASM Book based on the 1957 Albuquerque Conference on Heat Tolerant Metals for Aerodynamic Applications sponsored by the American Society for Metals and the University of New Mexico.

This is a book for the *designer* and the *metallurgist* who must have an increasingly effective partnership to achieve urgent aircraft and missile goals. It is a book for specialists in—

- **aerodynamics**
- **ceramic and cermets**
- **electronics**
- **heat flow**
- **high temperature properties**
- **lubrication**
- **material procurement**
- **mechanical structures**
- **thermodynamics**
- **protective metallic coatings**
- **vibrations**

This complete documentation of the problems facing metallurgy and design, fabrication and testing, this study of progress to date, should be in your library for study and reference use. It is a new, up-to-the-minute, authoritative book—order now.

$7.50 Postage Paid
203 illustrations
432 pages
6".x 9"
red cloth binding

AMERICAN SOCIETY FOR METALS,
BOOK DEPT. NO. MR
Technical & Engineering Book Information Service
Metals Park, Novelty, Ohio

Please send _____ copy(s) of "Metals for Supersonic Aircraft and Missiles"
☐ Bill me ☐ Bill my firm
Enclosed is: ☐ Cash ☐ Check ☐ Money Order
Send me the new ASM Book Catalog

Name _____
Street _____
City and State _____
Firm _____
Title _____

METALLURGISTS

Join with Engineers and Scientists at The Knolls Atomic Power Laboratory- now entering a new stage in nuclear power development

▶ **STARTING SALARIES TO $12,000**

Theoretical and experimental programs in progress at KAPL show indications of opening the way to a new generation of nuclear powerplants with vastly extended efficiency and service life.

Engineers or Scientists with significant related experience in the fields below are invited to inquire about current opportunities.

- Reactor materials development
- Nuclear materials application
- Process development metallurgy
- Mechanical metallurgy
- Materials irradiations experiments
- Applied ceramics
- Chemical analysis, vacuum techniques
- Analytical chemistry, X-ray diffraction

U. S. Citizenship Required

To expedite your inquiry, forward one or more copies of your resume, including salary requirement. Please also state your particular job interests. Address:

Mr. A. J. Scipione
Dept. 43-MH

Knolls Atomic Power Laboratory
OPERATED FOR A.E.C. BY
GENERAL ELECTRIC
Schenectady, New York

PLANT—CONTACT METALLURGIST

Minimum of two years in metallurgy, metallurgical engineering or comparable experience required. Hot rolled bar mill experience preferred. Cold finished bar mill experience desirable. Excellent opportunity leading to position of plant-contact metallurgist.

Salary commensurate with background and experience. Send resume to J. S. McCord, Vice-President, Bliss & Laughlin, Inc., 110 Hopkins St., P. O. Box 945, Buffalo 5, N. Y.

SURFACE METALLURGIST

RMD has an immediate opening for a metallurgist with a B.S. in Metallurgy or Chemical Engineering and a total of 5 years experience in two or more of the fields listed below:

(1) Electroplating and Anodizing
(2) Metal Cleaning
(3) Corrosion
(4) Metal-propellant compatability

The applicant should be able to prepare reports on his investigations.

Send resume or phone, collect:

Mr. K. J. Henderson
Reaction Motors
DIVISION
Thiokol
CHEMICAL CORPORATION
74 Ford Road Denville, N. J.
OAkwood 7-4620

Fuel and Materials Development

Senior Metallurgist, Physical Chemists and Engineers

Reactor Materials. Research involves investigation and analysis of mechanical and physical properties of metallic alloys and inter-metallic compounds. Materials are to be used in power reactors for fuel, and fuel cladding, moderators, control rods, and structural members. Studies will include analysis of materials after exposure to high temperatures and radiation fields.

Fuel Element Engineering. Responsible for the complete analysis and design of fuel elements. This includes nuclear, thermal, material, mechanical and cost analyses. Should be familiar with fuel life determination methods and reprocessing techniques.

Fuel Fabrication. Activities will include development fabrication of materials and fuel elements, for both plate and rod forms and complex assemblies. A knowledge of non-destructive testing methods is essential, in addition to familiarity with a wide range of material processing and fabrication techniques.

Irradiation Experimentation and Hot Lab Evaluation. Senior Research Engineers and Physicists are required to design and conduct irradiation experiments on developmental materials including reactor fuels. The individuals must be familiar with a wide range of radiation and temperature conditions. Experimental conditions will include the simulation of conditions expected in full scale power reactors. Also senior personnel are needed to develop equipment and techniques required for the post-irradiation testing and evaluation of these experiments.

For specific details write:
Mr. D. H. Newton, Personnel Office, Atomics International, 21600 Vanowen Street, Canoga Park, California.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.

NOW BASIC METALLURGY II

NEW COMPANION VOLUME TO FAMED BASIC METALLURGY I

This easy-to-read and practical book describes the equipment and its use for metallurgical operations. This is a practical guide to metallurgical equipment, test and techniques.

Well-illustrated with 67 pictures, 17 pull-out data sheets and 37 charts and graphs. Basic Metallurgy II contains a comprehensive 8-page index for handy use plus 68 references to other authoritative sources.

Table of Contents

PURPOSE AND KINDS OF TESTING
TENSION TESTING MACHINES
HARDNESS TESTING
OTHER MECHANICAL TESTS
NONDESTRUCTIVE TESTING
MACROSCOPIC TESTING
MICROSCOPIC INVESTIGATION
PYROMETRY
HEAT TREATING EQUIPMENT
PREPARED ATMOSPHERES FOR HEAT TREATMENT
CORROSION TESTING
MISCELLANEOUS TESTING

$7.50 . . . 232 Pgs. PLUS 17 Data Sheets . . . Red Cloth Binding

ASM Technical and Engineering Book Information Service
METALS PARK, Novelty, Ohio—Dept. 8R

Enclosed please find $..... for copy(s) of Basic Metallurgy, Volume II.

Or: Bill me ☐ Bill Company ☐

Name .....

Street & No. .....

City ..... Zone .... State .....

Company .....

Metallurgists

for Career Opportunities in
RESEARCH—DEVELOPMENT—PRODUCTION

A leading manufacturer provides exceptional career openings for qualified metallurgists with the ability to participate in—and lead—activities in the non-ferrous and special metals fields.

Challenging positions in:

ALLOY DEVELOPMENT

Metallurgist—with 1-3 years experience—to work with top level Research Group. Bridgeport, Ct.

PHYSICAL METALLURGY

Associate Research Metallurgist—minimum 5 years experience. Advanced degree preferred. To work on analysis of alloy properties, special testing and corrosion reactions. Bridgeport, Ct.

PROCESS DEVELOPMENT and PILOT PRODUCTION

Metallurgists—at all levels. Should have knowledge of stress analysis and mechanical property testing. Assignments to include problems in special metals fabrication. Adrian, Mich. and Riverside, Cal.

These openings offer outstanding growth opportunities in an expanding 12-plant company. A complete and modern benefits program is provided.

BRASS Bridgeport CO

Please send complete resume, letter of application, salary requirements and availability date to: Mr. F. J. Finsinger, Personnel Manager.

BRIDGEPORT BRASS CO.
30 Grand Street, Bridgeport 2, Conn.

a fine research position in

MECHANICAL METALLURGY

Battelle needs a high-level research engineer to do research in the general area of strength of materials—a combination of engineering mechanics and metallurgy. Specific interests: theory of elasticity, of plastic flow and fracture; dislocations in crystalline structures; creep, fatigue and thermal shock.

He should have an M.S. or Ph.D. in Mechanical, Metallurgical or Civil Engineering or Physics. Needed also, 2 to 5 years experience (and familiarity with recent developments) in above areas plus strong mathematical background. He should be keenly interested in being a leader in strength of materials as applied to industrial problems.

We offer competitive salaries; excellent benefits program; 100% research atmosphere; a fine city to live in. Write L. G. Hill,

BATTELLE MEMORIAL INSTITUTE
505 King Avenue, Columbus 1, Ohio

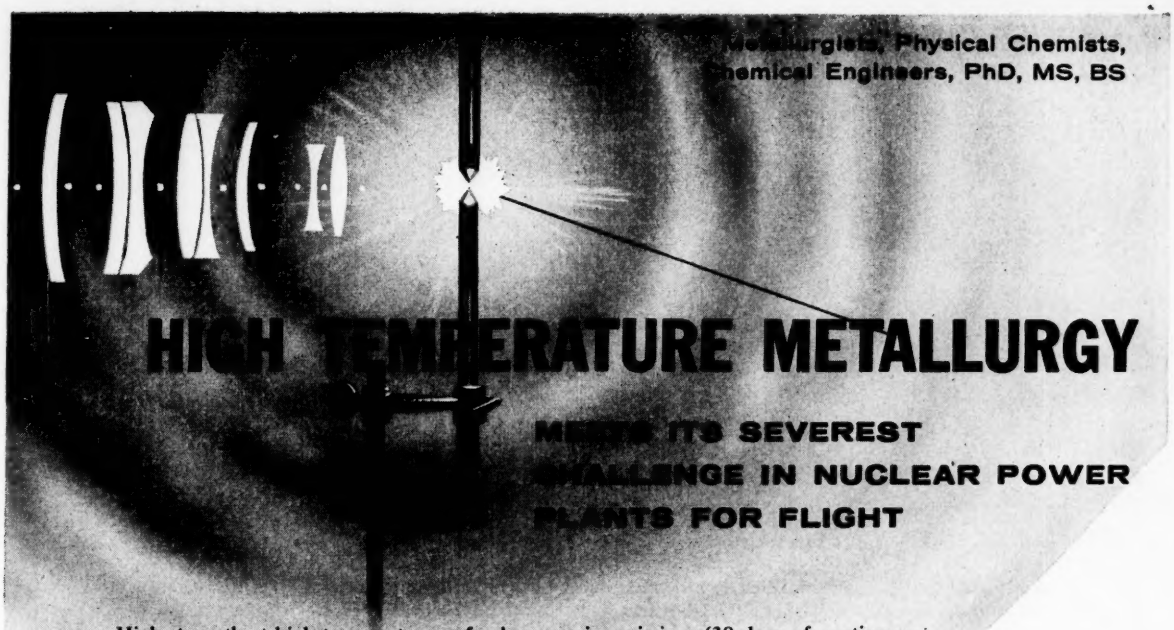
RESEARCH METALLURGISTS
MATERIALS ENGINEERS
CERAMIC ENGINEERS
SOLID STATE PHYSICISTS

Advanced Technology Laboratories currently can offer a number of senior and junior grade positions in connection with materials research and development programs in the nuclear field.

Opportunities exist for metallurgists, ceramic engineers and solid state physicists to carry out both basic and applied research in connection with fuel element development programs. Materials engineers are needed for several advanced reactor design projects. A number of interesting investigations are currently in progress covering the fields of mechanical metallurgy, alloy development, and ceramic fabrication techniques.

Send resume, in confidence, to Dean W. Townsend, American-Standard, Advanced Technology Laboratories, 369 Whisman Road, Mountain View, California.

ADVANCED *Technology* LABORATORIES
A DIVISION OF AMERICAN-Standard



Metallurgists, Physical Chemists,
Chemical Engineers, PhD, MS, BS

HIGH TEMPERATURE METALLURGY

MEETS ITS SEVEREST CHALLENGE IN NUCLEAR POWER PLANTS FOR FLIGHT

High strength at high temperatures—for long service missions (30 days of continuous flight and more are envisaged) is a primary consideration in the selection and development of materials for structures and components of General Electric's 2nd and 3rd generation nuclear propulsion systems for flight application.

A complex of additional parameters, however, must be taken into consideration by G-E engineers and scientists... radiation effects, nuclear properties for specific application, stringent weight limitations, etc.

Engineers and Scientists who value the opportunity to do original work with a company that fosters free inquiry and initiative, are invited to inquire about positions now open in both APPLIED RESEARCH *and* MATERIALS DEVELOPMENT:

DIRECT processing and procurement of basic alloys for elevated temperature applications. PhD, MS, 3-7 years experience.

CONDUCT liaison with technical production and project personnel on problems related to quality in fuel element production. PhD, MS, 3-7 years experience.

ADVISE Materials Testing Lab on materials problems and techniques. Direct experimental, physical, mechanical and electrical tests. PhD, MS, 3-7 years experience.

CARRY ON investigations of reactions in the solid state for Materials Testing Laboratories. PhD, Physical Chemistry.

PARTICIPATE in research on advanced moderator materials. Investigations in field of ionic, covalent and metallic bonding; hydrogen stability in metals at elevated temperatures; kinetics of advanced moderator systems. MS.

PERFORM laboratory investigations in metallurgical melting, casting, fabricating and forming processes. Also phase studies; solid solution alloy studies. MS preferred.

DIRECT studies on materials used in moderator materials development. PhD.

PROGRAM and evaluate specific tests on fuel element materials and assemblies. Compile and publish data. MS, BS, 5-7 years R&D experience.

CONDUCT project technical liaison on materials selection and processing. Develop design data on materials. BS, 5-7 years experience with high temperature alloys.

CARRY OUT liaison with materials subcontractors. BS with 7-9 years experience in development or sales engineering.

ASSIST in development of instrumentation for measuring high temperatures and other instrumentation. MS, BS, 1-3 years experience.

If you qualify, please write in confidence,
including salary requirements, to: Mr. P. W. Christos, Div. 43-MD
AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

GENERAL ELECTRIC

P.O. Box 132 • Cincinnati 15, Ohio

TOMORROW DEPENDS ON NUCLEAR POWER

Pictured above is David W. Lillie, a nuclear metallurgist and hence one of a group that's exceedingly important, alarmingly too few.

Dave is a recognized authority on nuclear research and physical metallurgy of reactor metals. Right now he is with the General Electric Research Laboratory doing specialized long range research in nuclear materials problems. But what makes him important to you, personally, is his authorship of the Metals Engineering Institute's home study course, *Metals for Nuclear Power*.

Now you can learn, from David Lillie, many aspects of currently available information about the role of special metals in the realm of nuclear power.

And keep this in mind as you read on—*Metals for Nuclear Power* contains *authoritative* material, *current* material, *valuable* material. It was written by an expert. It is offered by the Metals Engineering Institute—a division of the American Society for Metals, a respected and honored Society with *forty years* of educational success in the metal industry.

But why should the course interest you? Here's why. What is of more interest to the metal industry than the development of metals for nuclear power?—where is the potential greater?—and will not the demand for nuclear metallurgists grow and grow as industry becomes more and more nuclear minded? That's why you should take the course. Be ready. Be current. Be able. Be available.

If you have a B. Sc. degree or equivalent practical experience, your enrollment will be accepted; you will learn nuclear metallurgy via the Metals Engineering Institute.

"METALS FOR NUCLEAR POWER"

THE GREATEST, MOST AUTHORITATIVE AND UP-TO-DATE COLLECTION OF NUCLEAR METALS INFORMATION EVER ASSEMBLED IN COURSE FORM FOR INDIVIDUAL HOME STUDY OR IN-PLANT GROUP TRAINING.

Lesson 1—Energy Sources Today and Tomorrow.
Lesson 2—Atomic Structure, Particles, and Rays.
Lesson 3—Nuclear Fission and the Chain Reaction.
Lesson 4—Reactors: Principles, Components, and Types.
Lesson 5—Sources and Processing of Uranium Ores.
Lesson 6—Metallurgy of Uranium.
Lesson 7—Plutonium and Thorium.
Lesson 8—Moderators, Reflectors, and Shields.
Lesson 9—Reactor Control.
Lesson 10—Structural Materials.
Lesson 11—Coolants.
Lesson 12—Radiation Damage.
Lesson 13—Fuel Processing and Waste Disposal.
Lesson 14—Radiation Detection and Handling Techniques.
Lesson 15—Materials Research Safety in a Nuclear World.

This is only a brief sampling of the comprehensive material covered in *Metals for Nuclear Power*. Each lesson is thorough and extensive. Collectively, the lessons comprise a reference book unobtainable elsewhere.

17 COURSES FOR HOME STUDY OR IN-PLANT TRAINING ARE NOW AVAILABLE FROM MEI

- ☐ Elements of Metallurgy
- ☐ Heat Treatment of Steel
- ☐ High Temperature Metals
- ☐ Titanium
- ☐ Metals for Nuclear Power
- ☐ Stainless Steels
- ☐ Electroplating
- ☐ Blast Furnace Operations
- ☐ Arc Welding
- ☐ Gray Iron Foundry
- ☐ Oxy-Acetylene Welding
- ☐ Steel Foundry Practice
- ☐ Steel Plant Processes
- ☐ Tool Steels
- ☐ Copper, Brass and Bronze
- ☐ Magnesium
- ☐ Primary & Secondary Recovery of Lead and Zinc

METALS ENGINEERING INSTITUTE
a division of
AMERICAN SOCIETY FOR METALS

For full information on Metals for Nuclear Power and other MEI courses, please mail this coupon—at no obligation.

METALS ENGINEERING INSTITUTE
Metals Park, Dept. R89
Novelty, Ohio

Name .....

Address .....

City .....Zone .... State .....

Company .....

☐ Check here if you would like a brochure on in-plant training procedures.

MATERIALS & FABRICATION PREVIEW

of the SOARING 60's

METAL SHOW

CHICAGO

International Amphitheatre, Nov. 2-6, 1959

Here is an atmosphere steeped in discovery of the future — a preview of the kind of metalworking magic and technical wizardry that will propel America into the soaring 60's. Inspiring exhibits and thought-provoking technical sessions will draw 50,000 men of metalworking into a dynamic conclave of progress-producing activity.

Plan NOW to attend—you'll come away with new ideas, better equipped for the challenge of competition in the 60's!

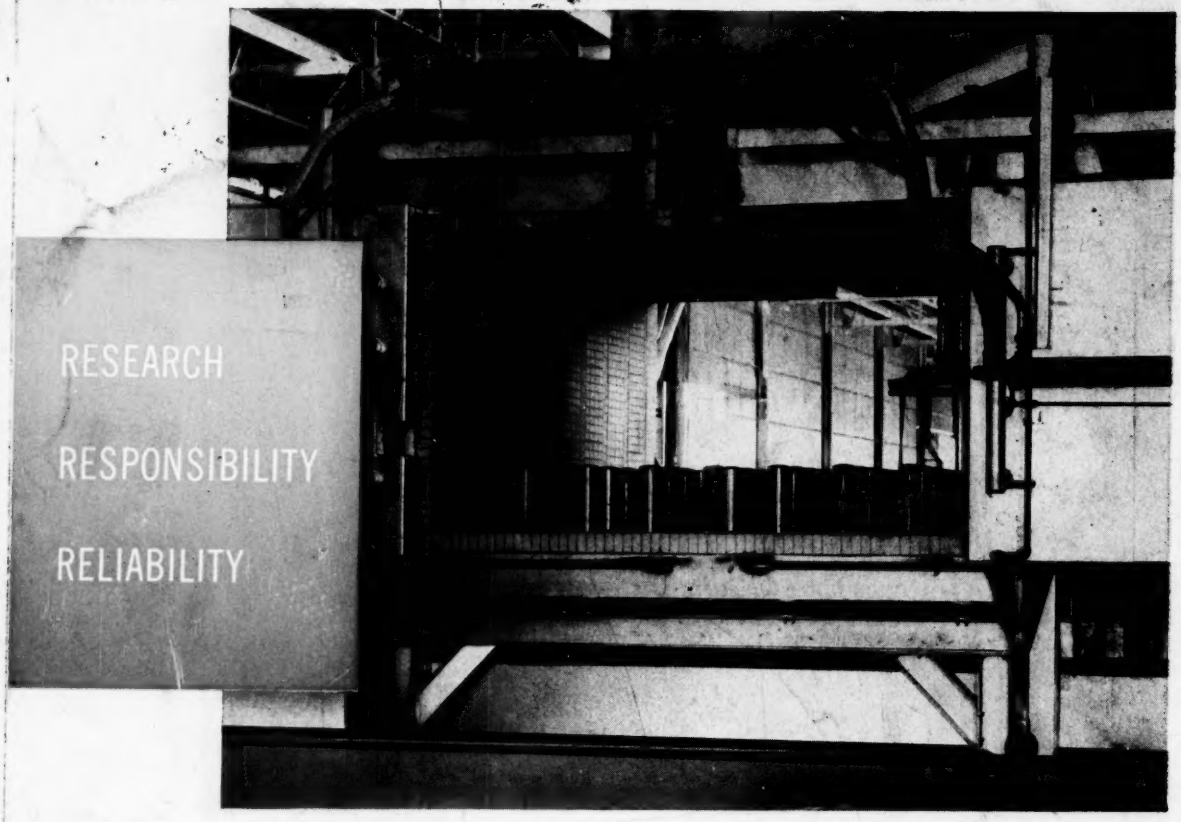
EXHIBITORS . . . A FEW EXCELLENT SPACE LOCATIONS STILL OPEN—WRITE, WIRE OR CALL COLLECT FOR LIST OF AVAILABLE BOOTHS.

NATIONAL METAL CONGRESS and EXPOSITION

Sponsored by the AMERICAN SOCIETY FOR METALS

Metals Park • Novelty, Ohio

Cooperating Activities: The Metallurgical Society of AIME; Society for Non-destructive Testing, Inc. Associations presenting technical sessions in cooperation with ASM: Metal Powder Industries Federation; Metal Treating Institute; Ultrasonic Manufacturers' Association; Special Libraries Association—Metals Division; American Society for Testing Materials—Committee B-9; and the extensive programs of the American Society for Metals with the William Park Woodside Memorial Sessions, and ASM Metallurgical Seminar.



Chemistry, Combustion, Electronics, Metallurgy and Mechanics are all important factors in Holden engineered products.

Coordination between research and engineering is vital in the production of equipment and material that will assure economy and efficiency in all heat treating processes.

This places the full responsibility directly on The A. F. Holden Company as a single source for anything in heat treating equipment. It assures you complete reliability for all your heat treating requirements.

Write for any information you need

HOLDEN
METALLURGICAL PRODUCTS
Include:

The Best of Everything for Heat Treating

Exclusive Luminous Wall Firing

Special Design Service

Conversions • Remodeling Consulting

Controls • Conveyors Chemicals

Everything in Salt Baths

THE A. F. HOLDEN COMPANY

3 F.O.B. Points for Holden Metallurgical Products

EXECUTIVE OFFICES AND PLANT
14341 SCHAEFER HIGHWAY,
DETROIT 27, MICHIGAN

EASTERN PLANT
460 GRAND AVENUE,
NEW HAVEN 13,
CONNECTICUT

WESTERN PLANT
3490 EAST RANDOLPH
LOS ANGELES
CALIFORNIA

HOLDEN
METALLURGICAL PRODUCTS

TRADE MARK REGISTERED